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AGRONOMY, HANDLING, PROCESSING, STORAGE AND PROTECTION
SOILS, CHEMICALS, IRRIGATION, ENGINEERING AND ECONOMICS

VOLUME 7, No. 10 OCTOBER 1955

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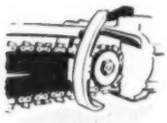

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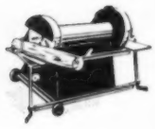

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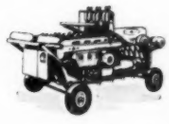

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Vol. 7, No. 10

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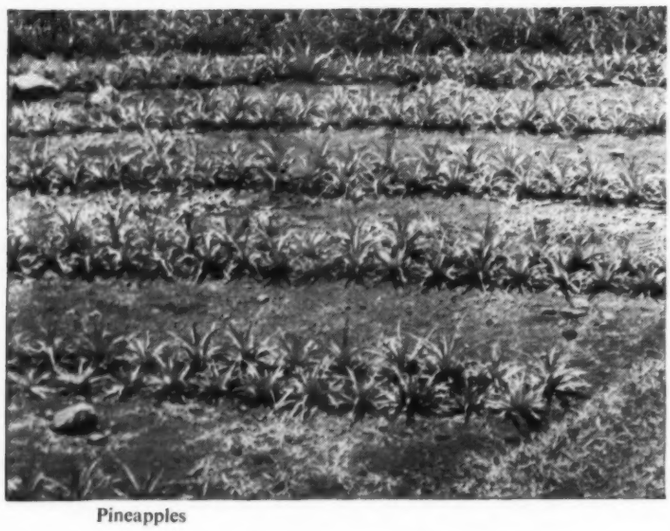

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Editorial Comment

416,000 acres

IN a country the size of Britain, or, at any rate, of England and Wales, 416,000 acres is an important quota of soil. It represents about one-eleventh of an acre per head of population; and it is soil that enjoys a temperate climate and possesses a cropping capacity (potential or real) that many other countries in the world can but envy. Yet from the preliminary results of the latest Agricultural Census for England and Wales (June 1955) it is the area of arable land that has been 'lost' since 1954—*in a single year* 416,000 *acres less have been tilled!* Nevertheless, we are importing more and more animal feeding-stuffs, 2½ million tons more in 1954–55 than in the last year of Government-controlled importation; and the great majority of that 2½ million tons has come from dollar sources! In two years national expenditure upon feeding-stuff imports has jumped by at least £27 million per annum. No doubt there are a number of people who are ready to defend this contrary state of affairs, who will trot out the old and dubious argument that it is cheaper to buy abroad when the price is 'right', etc. It is an argument that wins much more respect in Britain than in Holland or Denmark. For who can imagine the Dutch or the Danes letting cropland diminish whilst raising their animal-feed imports?

However, it is not to be supposed that all the 416,000 acres has lapsed into non-productive land. About 250,000 acres would seem to have entered the permanent grass-land class; and the rest, more happily, has added itself to the acreage of temporary grass-land. Some may say that this is all to the good, that grass-land produces meat and milk anyway, etc. This would be a more acceptable argument if there was not already a total acreage in England and Wales of 4 million acres of temporary grass and 11 million acres of permanent grass. Grass-land, properly fed and managed, can indeed be highly productive, but we do not need more of it to take advantage of modern grass-farming methods. Better use of the existent grass-land acreage, or merely of 10% of it, will produce far more extra meat or dairy produce than increasing the grass-land acreage by some 416,000 acres.

Much of the fall in arable acreage can be attributed to a decline in wheat. Indeed, the fall in wheat acreage was 469,000 acres, and of mixed corn 134,000 acres; these falls were partly offset by rises of 229,000 acres for barley and 29,000 acres for oats. But the overall drop in the cereal acreage was 345,000 acres—and all this in a single year! Surely if we need more grass, whether for grazing or for preservation, it should be obtained from the already huge grass-land acreage. Surely, too, the 345,000 acres of lost cereal land should have been devoted to producing animal foods *at home* to relieve some of the soaring dollar expenditure upon imported feeding-stuffs.

It can be hoped that the census of June 1956 will show a firm reversal in this trend of arable decline. The 1955 spring price review certainly helped to restore farming confidence, and mid-1955 fears of a general balance-of-payments crisis may well check the rising tide of imported feeds. But a further fall in arable acreage, coupled with further increases in imports, will represent not only a setback to farming prosperity, but a fundamental blow to the national economy. The productivities of farmland and factories are indivisible.

Plan for African agriculture

THE Southern Rhodesia Government's plan for the full implementation of the Land Husbandry Act is described in a report published on 18 July. The plan will revolutionise native farming, increasing cash income in the next eight years from £3,500,000 a year to £11 million and to £20 million in 20 years. It will cost approximately £6,600,000 and will involve 31 million acres—or 47,000 square miles—of native land. The aim, in the first five years, is to double the average family cash income. The object of the plan is to implement the Land Husbandry Act of 1951 and switch native agriculture from a communal to a land-ownership basis. The report shows that, thanks to the extension work of the Native Agriculture Department, crop yields in native areas can be doubled through good husbandry. The switch-over from the traditional community system to one of personal ownership will involve, between now and the end of 1959, surveying native areas, classifying land, developing water supplies and giving intensive instruction to Africans to help them open up holdings and increase both crop and cattle production. The various phases of the plan are given in the report on a year-to-year basis.

The total cost of the five-year plan will be approximately £6,600,000. The Government has already provided a special appropriation of £992,312 in the financial year ending July 1956. This, together with Government appropriations foreshadowed in each of the next four years, provides for a total contribution from general revenue of just over £3,500,000. A feature of the Government contribution is that it involves diverting the greater part of the resources of the Native Agricultural Department to the work involved in the implementation of the Act. From the Native Development Fund will come a total contribution of £1 million spread over the years. Thus the total amount available

for the implementation of the plan will be, from the two sources, £4,500,000, leaving about £2 million still to be raised.

In a foreword to the plan, Mr. P. B. Fletcher, Minister of Native Affairs, emphasises that the plan is based on sound economics and will greatly strengthen the economy of the Federation. It is claimed that the stabilised native agricultural and non-agricultural populations, which the five-year plan will bring, offer ' the soundest prospect both for the social advancement and the political stability of the native in the future '.

Mr. P. B. Fletcher describes the scheme as ' probably one of the most extensive of its kind ever attempted in Africa '. He says that his confidence in the scheme is based on the happy experience of native co-operation, without which there could be no progress. Consulted on every detail in the Land Husbandry Act, the native people had the courage and wisdom to participate in an agricultural revolution which cuts straight across their time-honoured traditions and tribal customs. He says of the implementation proposals, ' I commend these proposals as a carefully planned attack on the squandering of our most valuable asset '.

Russian grain crop

ALTHOUGH no final estimates or forecasts are being offered, a senior member of the Russian Ministry of Agriculture has announced that this year's grain output is promising and that European Russia might well enjoy its best year since the war. Such results cannot be expected in eastern regions, however, because of drought.

According to *Pravda*, the Krasnodar territory in the Kuban grainlands was the first to complete the gathering of eared crops and to fulfil the plan for grain procurement ahead of schedule, having already delivered more than 81 million poods (1 pood equals 35 lb. approx.) to the State granaries. Collective and State farms in the Kherson *oblast* have delivered more than 40 million poods, more than half of it as wheat. A final crop of 58 million poods is estimated for this area, compared with a total of 50 millions in 1952, their best year.

According to *The Times*, the Russian Press is full of such examples. *Pravda* states that hundreds of collective farms have already fulfilled their quotas and continue to deliver grain over and above the plan. Much is being made of what these good results mean in terms of greater rewards in kind and money for collective farm workers.

In some areas of the Ukraine, however, which were, in fact, the first to start harvesting, a large proportion of the crop was, until recently, still standing untouched and in some places going to seed uncut because combines were not utilised properly or threshing had not been maintained at its first momentum.

This year 26 million hectares, some of which had been idle since the war, have been reclaimed and 20 million hectares of it sown. This is expected to be expanded to 30 million hectares by next year as part of Russia's aim to raise grain production to 10,000 million poods.

Colonial development

A RECORD amount of £15,936,820 was contributed by the United Kingdom last year towards the development and welfare of the colonial territories. Of this sum, £3,144,537 was for agriculture and veterinary schemes and £1,173,381 was for research.

Quoting these figures, the annual ' Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies —1 April, 1954 to 31 March, 1955 ', published recently by H.M.S.O., states that research grants included £133,157 for agriculture and £54,413 for locust control.

In all, £3,763,351 was provided for Nigeria, including £1,689,578 for the Northern Region, £707,091 for the Eastern Region and £985,659 for the Western Region. Federal expenditure of £381,023 has also been provided. Of these sums, large amounts were allocated for agriculture.

Amounts provided for the East and Central African territories included £785,438 for the intensification of African agricultural development in Kenya. Grants to the West Indies included £29,555 for rice investigation in British Honduras.

Strangers in the tea cup

BECAUSE of higher wages, taxes and duties imposed by the governments of tea-growing countries the question has been raised whether or not the time has come for the young men of the U.K. to take risks and begin pioneering once again. Consumption of tea has been mounting all over the world; the price of tea is soaring, though not in the same degree as other goods, such as milk, sugar, bread, cigarettes and beer. Several Government-appointed commissions have been studying the problems associated with the production and marketing of India's tea. Probably the object of such investigations is to ensure even larger financial returns to the coffers of the local government in the present conditions of limited supplies.

If, however, a commission were set up to estimate the likely course of future events in the tea world, it may report differently. Many strangers are already appearing in the tea cup—Africa, Australia, the Azores, the Carribean Islands, Georgia, Hungary, Kashmir, Mauritius, North-West Pakistan, the Ukraine and others. They are unimportant now, but tea-consuming interests will search elsewhere for other opportunities

when, on top of all duties, taxes, etc., the cost of replanting established areas has increased from £30 to £50 over the last century. Tea has been planted in many unlikely places, even on a small island in Glenguriff Bay (South Eire), where a trial lot of Assam seeds was planted. It cannot be said where it will next be grown on a large commercial scale; there are many square miles in the tropics and in the Northern Hemisphere with suitable climate and rainfall, and in Australia, for instance, where many acres may be offered to expert planters who would like to use the mechanised pattern of the U.S.S.R.

Intensity of daylight

THE intensity of light is ever becoming of greater importance among physiologists. It is, indeed, becoming recognised as being one of the ruling factors in the environmental requirements of plants and crops, and of animals as well. The environment is made up, therefore, of differing degrees of soil fertility, moisture, temperature range and duration and intensity of daylight, to quote the main influences.

Much of our enjoyment of summer holidays by the sea, and the browning of our skins, is due, not to the salt sea air, but to the unobstructed horizon, which permits a greater degree of light and light intensity both from a wider expanse of sky and by reflection from the sea. The growth of island vegetations and crops is surely made more vigorous and luxuriant by this cause.

This being so, the recording of the hours of sunshine and of cloud by world-wide meteorological stations is somewhat old-fashioned and out of date. An opportunity is given of providing much more valuable data if the degrees of light intensity were measured instead, by hour, by day, per month and year.

A modern photographer does not take a picture without measuring the light intensity. His instruments are becoming more efficient, and it should not be beyond the ingenuity of man to evolve an automatic recording instrument which would supply a graph not only of the amount of sunshine and cloud, but of the light intensity as well.

Irrigation in Ceylon

DURING the year 1954 Ceylon's Department of Irrigation provided 19,409 acres of new land with irrigation facilities for the first time (*Administration Report of the Director of Irrigation for* 1954, Government Publications Bureau, Colombo). The following statement shows the progress made in 1954 and the total area of land irrigated under major and village irrigation schemes:

	Acres irrigated under		*Total*
	Major works	*Village works*	
At end of 1953.. ..	253,882	410,492	664,374
Provided during 1954 ..	17,551	1,858	19,409
At end of 1954.. ..	271,433	412,350	683,783

In addition, irrigation facilities were provided for 9,715 acres of land already under cultivation, and 2,496 acres were provided with drainage, flood protection and salt-water exclusion facilities.

The aim of the Department is to irrigate 20,000 acres of new land every year. With this in mind, a start was made in 1954 on three new major schemes—the restoration of the Padawiya, Pavatkulam and Vavunikulan reservoirs—with which Australia is helping under the Colombo Plan. The restoration and improvement of such ancient irrigation works is contributing to the success of the colonisation schemes in the Dry Zone. A systematic analysis of the water resources of the country's river basins as a basis for preparing development plans was initiated; and the proposed Walawe Reservoir Scheme—designed to irrigate 120,000 acres and generate 6,000 kW of electricity—had been investigated by a U.S. firm which had recommended that the Government should consider action.

European programme

THE 18 member countries of the Agriculture and Food Committee set up by the Organisation for European Economic Co-operation last January have adopted a long-term programme of close co-operation in increasing productivity on the land and streamlining marketing methods.

The programme, which is divided into four parts, embraces, firstly, co-ordination of agricultural policies by the member countries to facilitate the organisation of the European agriculture market and reduce difficulties encountered in some national markets; secondly, special action on consumption and distribution aimed at promoting the qualitative and quantitative increase of demand; thirdly, special action concerning expansion of trade and the stability of both import and export markets; and, finally, productivity, including the improvement of general farming conditions, the exchange of economic and technical information, better marketing systems and better use of farm requisites.

Referring to trade, the Committee draw attention to the many obstacles barring multilateral agreements and suggest discussion by the Deputies Committee of minimum prices, enlargement of quotas, long-term agreements, or a combination of these.

The Committee of Deputies has been instructed to make a proposal for the abolition of restrictions on imports of goods used in agriculture, whether of agricultural or industrial origin.

The topical question of surpluses is expected to be discussed under the second and third headings.

The Agricultural and Food Committee also decided to work closely together with the United Nations Food and Agriculture Organisation and the interested international non-governmental organisations.

U.S. farming methods

A TEAM of five British experts, who recently returned from a visit to the U.S.A. and Canada, where they studied farming conditions and advisory services on behalf of the Nuffield Foundation, have suggested methods by which the British industry might benefit from the uninhibited American approach to agriculture.

Although the U.S.A. did not possess the wealth of experience present in Britain, there was a greater readiness to accept new ideas. The use of equipment had occasionally exceeded the bounds of real efficiency, possibly because of America's enthusiasm for machines, which was attributed to plentiful supplies of cheap electricity. Some work could have been done more quickly and less expensively by manual labour. The team hinted, however, that further progress in Britain might depend on the nation's ability to extend rural supplies and reduce costs.

Among the team's outstanding recollections were milking sheds that could be cleaned with powered gear and from which milk was conveyed in long glass tubes to dairies or bulk storage tanks. They were also impressed by the free use of elevators for moving fodder and other material and by the way in which the design of farm buildings had been adapted to allow the use of machines. On one holding silage was cut by electricity and conveyed by belt to the cowsheds.

One member of the team, Mr. B. H. Harvey, Principal of the Essex Institute of Agriculture, referred to experiments in Massachusetts in the collection of milk two or three times a week, the milk being stored in bulk tanks at a temperature of 40° F. The economies in the costs of collection suggested that the price to consumers could be much reduced.

The report of the team will be issued later this year by the Nuffield Foundation.

Agricultural credit

AT a time when production costs are again rising, a reduction in agriculture's main outside source of finance would seriously prejudice the food production programme. It is therefore to be hoped that British banks will take full account of the lead recently given by the Economic Secretary in the House of Commons and will appreciate, as he does, that the maintenance and encouragement of agricultural production will make a vital contribution towards easing our current balance-of-payments problem.

The Secretary was replying to a question asking whether the Chancellor of the Exchequer would reaffirm his directive to the banks of March 1952, bracketing agriculture with the defence and export industries for priority for bank advances.

In his reply he said that the Chancellor of the Exchequer stated, in his letter of 25 July asking for a reduction in the total of bank advances, that it was for the banks to decide what steps they must take in order to make this policy effective. He had no doubt that in doing so they would give full weight to the importance of agricultural production.

Removing salt from sea-water

THE Dutch Institute for Applied Physics Research has developed an entirely new process for desalting brackish water and sea-water. The process of desalting by electrodialysis is to be adopted internationally on a large scale. Research is to be undertaken by the Netherlands, Britain, Australia, South Africa and, probably, the U.S.A. France is also interested and talks are in progress with other countries.

The initial costs of the research over a period of two years are estimated at 400,000 guilders (approximately £40,000 sterling).

The penetration of salt water to farming land is one of the biggest problems in the Netherlands and large sums are spent annually to counteract its harmful effects on crops.

Errare humanum est

IN the last issue of the journal reference was made, in the notice of the Australian farmers' visit, to that delightful part of the English countryside known as Crux Easton in North Hampshire. Now, owing to a flight of fancy on the part of the Editor, this picturesque parish was transposed to Northamptonshire.

The Editor acknowledges his error, but claims mitigating circumstances, for he, with the Australian party, comes from the Antipodes and thus is a 'New Englishman' as yet confused with British place-names and their abbreviations.

There is no doubt that Northants would be the gainer and North Hants the loser if Crux Easton were to be treated in such summary fashion, but the inhabitants are rooted solidly in their native soil and we must allow them to continue to live and work undisturbed by wholesale transportation. By way of retribution for this geographical error, the Australian graziers and farmers have confirmed that their visit to Crux Easton was the highlight of their English tour.

And now we return to our study of the British gazetteer !

DEVELOPMENTS IN MOTORISED AGRICULTURAL MACHINERY

E. HARRIS and W. E. KLINNER

(*National Institute of Agricultural Engineering*)

'The implement is all-important and tractors should be designed around it'. This has been stated at various times, but the implications contained in this statement are only being realised in recent times. When the tractor was first introduced, its main purpose was to replace animal draught and steam power as a mobile or stationary prime mover. In this capacity the main design requirement for tractors was the provision of an engine, transmission and a means of propulsion and drive. Tractors were then used for a limited number of operations, especially for heavy work such as ploughing. The introduction of pneumatic tyres, power take-offs, improved linkages and power lifts, as well as the reduction in the power/weight ratio, made possible by advances in metallurgy and engine design, gradually increased the versatility of the tractor to its present state.

UNLIKE certain oversea territories where heavy track-laying tractors are in the main required for reclamation and heavy cultivation work, the chief demand in most European countries is for universal tractors capable of being used for practically all tasks formerly carried out with animal draught. On the family holding the use of a tractor is rarely economical unless all draught animals can be abolished. Moreover, the increasing shortage of farm labour and its high cost make it essential for the tractor with suitable implements to be used for agricultural operations formerly done by hand labour. Thus two main trends of development seem to emerge, one towards the creation of an extremely versatile tractor or implement carrier, the other towards the provision of auxiliary engines in tractor-drawn or self-propelled machines. In either case, the main aim is to provide mechanical power in the most convenient and efficient way.

The trend towards the implement carrier

In recent years the original conception of the tractor as a prime mover for pulling and driving machinery has been changed to some extent and the tractor is gradually becoming a carrier for the implement or machine, as well as its power unit. With this in view great advances have been made in improving the visibility of the tools, the convenient placing of controls, ease of mounting implements, and the adaptability of the tractor to varying speed and power requirements. The problem of providing closely spaced variable speeds is being tackled in different ways, either by a mechanical transmission with two gear ratios providing a total of 10 forward speeds in some cases, or by the use of hydraulics. In one hydraulic drive subsequently fitted to the tractor, the hydraulic pump of the tractor delivers oil under pressure to a motor, which drives the rear wheels through the p.t.-o. shaft and transmission. This enables the tractor to travel at the very low speed required for transplanting, hand singling and similar tasks. The same may, of course, be achieved by means of a reduction gearing which is now avail-

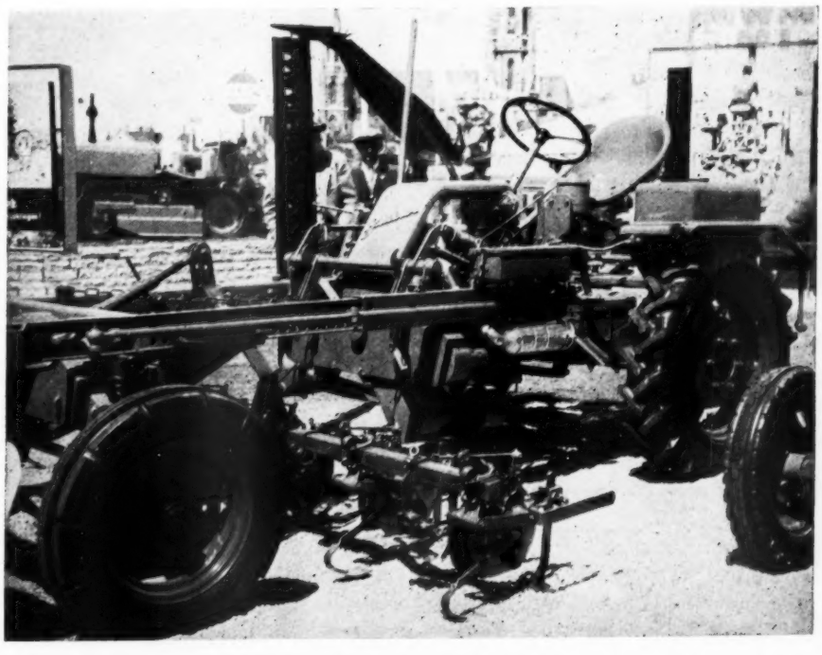

Fig. 1. The telescopic, box-section chassis permits the wheelbase to be varied according to requirements

able, usually as an optional extra, for many models.

Infinitely variable speeds operating in both directions from rest up to a certain maximum are, however, best obtained through a hydrostatic transmission, such as that incorporated in the N.I.A.E. prototype hydraulic tractor. In this example, oil under pressure is delivered from an engine-driven piston pump to wheel motors, thus obviating the need for a gearbox, mechanical transmission and clutch. A single lever controls the oil flow, and hence the speed and direction of travel. This makes the operation of the controls simple and reasonably foolproof —an important consideration when the tractor has to be operated by native or unskilled labour. Simplicity of operation is also important in conventional tractors in order to eliminate driver fatigue, and greater attention is now being paid to convenient placing of the controls and to the comfort of the driver by providing well-sprung seats, protective cabs etc.

Controlling the implement

As tractors are being increasingly used for inter-row cultivation, and in particular for hoeing close to the rows, it is very important that the driver should have an unobstructed view of the tools while sitting in a comfortable position, which allows accurate working for long periods without undue fatigue. For this purpose it is essential to provide a clear space between the front and rear axles for mid-mounting and easy control of implements. In order to accommodate mid-mounted implements, the wheel-base of some tractors has been increased and a greater ground clearance provided between the axles, so that the implements can be raised sufficiently out of work to enable the tractor to travel freely over rough ground. In some cases the driver's seat has been brought forward to a position in front of the engine, in others the engine unit and transmission have been designed with a view to obtaining a relatively clear space immediately in front of the driver, air cleaners and exhaust pipes being positioned where they do not obstruct the view. Moreover, power lifts and p.t.-o. shafts are sometimes arranged to operate also mid- or front-mounted implements.

In this respect the hydraulic tractor also has many potential advantages. In the absence of a gearbox, mechanical transmission and clutch, it is possible to obtain a large clear space between the axles and to design the tractor in accordance with the needs of the implements or machines. The power-transmitting connection between the wheels and the oil pump supplying the wheel motors is a flexible one and these units can be mounted in almost any position in relation to each other. The development of hydrostatic transmission for farm tractors is likely to provide the answer to many problems at present facing the designer of tractors and implement carriers. However, a great deal more research and development work will be needed before the hydraulic tractor or implement carrier becomes a reality for practical use on the farm.

At present it is not at all certain whether the implement carrier of special design has come to stay or whether the development will be a less drastic one with tractors of more or less conventional design, but adapted to carry mid- or front-mounted tools. Several examples of this type of tractor are now on the market and there is a definite trend towards the creation of combined tractor/implement carrier units of great versatility in the small and medium horse-power ranges.

Powered toolframes

As more new models appear on the market or as prototypes are designed, it is becoming increasingly difficult to draw a definite line of distinction between this type of tractor and the implement carrier proper. In fact, in the case of the implement carrier shown in Fig. 1, conversion into a tractor of more or less orthodox design is possible by shortening the wheel-base. The box-section framework of the chassis as well as the steering rods are made telescopic, so that the wheel-base can be varied from about 68 to 100 in. The shorter wheel-base is similar to that of conventional tractors of the same horse-power and can be extended to the maximum in accordance with the type of implement or machine to be mounted, bolt holes being provided along the longitudinal members at short intervals. As in the case of most implement carriers, a little extra space between the axles is obtained by the use of an air-cooled engine employing a flywheel blower, since this type of engine can be built somewhat shorter, at the expense of width, than a water-cooled engine of the same horse-power. The chassis of this implement carrier is of rectangular shape in plan view, which is typical of several models, and seems to be particularly useful for the mounting of root harvesters between the axles. Some other models, however, employ a central longitudinal member of box section, connecting the two axles. This member also accommodates the controls and, in one case, the drive shaft; some of the machines, such as seed and fertiliser drills, for use with this type of tractor are made in two parts, one part being attached to each side of the central member.

Two-way operation

Another approach to the problem of providing an easy means of mid-mounting implements is given by the use of arched members curved upwards between the two axles to allow adequate clearance for most machines, including drills. An interesting design is also shown in the prototype implement carrier (Fig. 2). In this case the front axle has been completely eliminated and the front wheels are attached in a fixed position so that the track width can only be altered at the rear. However, the absence of a connecting piece at the front is likely to facilitate the attachment or hitching of equipment and it will be noted that the trailer hitch is in front of the engine. Like some other implement carriers and tractors, this machine is capable of travelling through the same gears in both directions, for which purpose the controls and the driver's seat are reversible. Two-way operation has many advantages, especially in conjunction with rear-mounted front-cutting mowers and binders. The chief merit of the specially designed implement carrier with its engine unit placed in a position where it does not obstruct the view on the implement, usually close to the rear axle immediately in front of or behind the driver's seat, or in one case on the front axle, is that it enables easy attachment of a large range of implements and one-man control of one or more implements and machines, which can be mounted in front, in the centre, and at the rear.

Once-over operation thus becomes possible on many tasks and is particularly useful for seedbed preparation where, for instance, a plough, harrow, fertiliser distributor and possibly also a seed drill can be simultaneously attached to the implement carrier in various positions and controlled by the tractor driver. Another combination shown in Fig. 3 is that of a front-mounted side rake, and a mid-mounted forage harvester blowing the cut crop into a trailer hitched at the rear. For root harvesting a beet-topping and saving unit, a beet harvester and a trailer can be attached to clear the beet from the field in one operation.

Thus for all but the heavier tractors, notably of the track-laying type, the conception of the tractor and, consequently, its basic design appears to be changing and the emphasis seems to have shifted to the implement or machine, with the tractor providing a wheeled power-driven chassis to carry the machinery, as well as the power to operate it.

Fig. 2. The open-ended tubular frame of this prototype implement carrier facilitates mounting of equipment

Motorised machinery

The idea of combining the machine with its power unit is reflected not only in the tractor design trends already discussed, but also in many other examples. Thus a French firm developed a combine harvester built on a strong two-wheeled chassis, which could be raised sufficiently at the front to allow the tractor to be reversed into a position behind the cutter bar and reel, the chassis then being bolted to either side of the tractor in its normal working position. Most tractors can be attached or detached in a few minutes, and thus become available for other tasks.

In the case of the Ferguson tractor, however, conversion takes somewhat longer, as the front wheels have to be removed and fitted under the threshing mechanism at the rear, so that in effect the drive wheels become the front wheels of the machine and steering is effected with the rear wheels in the conventional manner of self-propelled combine harvesters. A later, self-propelled model by the same firm is powered by a 50-h.p. diesel engine and can be taken apart into three major components; these components are interchangeable with a number of other units to allow conversion into a stationary thresher, a forage harvester or a pick-up press. In another application, a tractor run on to the top of a heavy set of rollers adds weight to the rollers and supplies the power to drive them.

Although a saving in components is sometimes achieved by a combination of this kind, greater versatility of the machinery may be obtained only at the expense of time-consuming and laborious conversions. This is particularly undesirable in the case of harvesting machinery when the time factor is of great importance, and preference is likely to be given to machines offering quick and easy attachment. In this connection the semi-self-propelled machines developed in the U.S.A. are of special interest. The range of machinery comprises a forage harvester, a pick-up baler and a combine harvester. These can be easily attached to one side and to the rear of the tractor by one operator, who simply reverses the tractor on full lock until the special hook on the lower lift links can be engaged into an eye on the machine; further straight reversing then couples the tractor to the machine at the front by means of a latch.

The side draught necessarily resulting from such an arrangement is overcome by fitting the single wheel on the offside of the machine with a traction tyre and driving it instead of, or in addition to, the offside rear wheel of the tractor. An auxiliary engine can be provided if necessary. This method of coupling also offers the advantage of positive control, high manoeuvrability, easy supervision of working parts, such as the cutting platform of the combine harvester and the bale knotter, and one-man operation for most tasks—advantages usually associated with self-propelled machinery.

In farming it is often necessary to carry out several tasks at the same time and if the tractor is the only source of power available difficulties may arise in allocating this power and bottlenecks may occur. On the other hand, by employing self-propelled machinery the tractor becomes available for other tasks and the whole operation can be speeded up or several operations carried out simultaneously. Thus, when using a self-propelled

combine harvester, the tractor becomes available for work with a pick-up baler or for hauling the straw and grain from the field. Moreover, there is no need to open out the field and the unit is highly manoeuvrable.

Most machines are capable of harvesting a large variety of grain and small-seed crops under greatly differing conditions, as encountered in temperate and tropical climates. Great attention is also being paid to improve the operator's comfort and to eliminate fatigue. Thus power steering, electrically or hydraulically operated lifts for raising and lowering the reel and cutting platform, hydraulic adjustment of the drum speed, devices for keeping the harvester level on side slopes, a hydraulically operated infinitely variable transmission providing a range of speeds around each mechanical gear selected, built-in straw presses or straw cutters, and other features incorporated in some models of combine harvester facilitate operation and make it more efficient.

Sowing machines

Another peak period on most farms is during spring cultivation and it is therefore not surprising to find several self-propelled sowing machines on the market. These can hardly be distinguished from implement carriers proper, except that the latter are usually employed with a large range of equipment, whereas the former are primarily designed for use with drills or seeder units. In fact, two models take the form of a power-driven forecarriage for a seed drill and have all controls, including the steering wheel and driver's seat, duplicated on either side of the chassis, so that the driver can easily follow the mark left in the previous bout. In accordance with general trends, this type of machine is gradually becoming more versatile and is used a great deal in conjunction with inter - row cultivation equipment, sprayers etc.

In addition, there are, of course, several self-propelled machines, usually single-purpose units, which are mainly designed for contractor work or for large farms. Particularly in the Soviet Union there is a tendency to create high-capacity, self-propelled machines with great working widths to deal with light crops on large areas. This type of equipment is useful only when the number of operational hours per annum is sufficiently high to make it economical, but this is rarely the case under European conditions, except with contractors or co-operatives.

Power where it is needed

Modern developments have made it possible to apply the power direct to the working elements either through the agency of an auxiliary engine or the p.t.-o. shaft. Drive from a separate engine enables the working speed to be kept constant while the forward speed is varied according to the prevailing conditions, and a machine with a high power requirement to be operated by a relatively small tractor or with animal draught. This means in effect that the power for working the machine is separated from that needed for forward propulsion—a feature also incorporated in one model of self-propelled combine harvester in which two separate engines are used. Small air-cooled engines are also employed for driving machinery not operated with a tractor, such as silage cutters, knapsack sprayers, plot drills etc.

Four-wheel drive

Power take-off drive has greatly simplified the design of some machines, such as binders and mowers, by obviating the need for ground wheel drives. Where it is essential to fit wheels, these can often be driven from the p.t.-o. to improve the performance. This applies in particular to p.t.-o.-driven trailers, which, by providing a four-wheel drive with a substantial load on the second pair of driven wheels, greatly improve adhesion and increase the tractive effort of the whole unit. Some tractors are provided with two p.t.-o. shafts, one being dependent on the main clutch and driving, *e.g.* a trailer, at a speed related to the forward speed of the tractor, the other being controlled by a separate clutch to drive the machine at a constant speed irrespective of the forward speed. Recent applications of this method of driving are p.t.-o.-driven plough wheels and rotary or reciprocating harrows. One p.t.-o.-driven axle for a two-wheeled tractor is so arranged that it can be used as a chassis for a trailer or for attaching implements, *e.g.* ploughs, thus creating in effect a four-wheel-drive tractor with handle steering and with mid-mounted implements.

Four-wheel drive is a convenient means of increasing the tractive effort of the tractor under difficult ground conditions. It is incorporated in some tractor models of conventional design, but having traction tyres on the front wheels. The typical four-wheel-drive tractor, however, has all four wheels of equal size and a relatively high percentage of the weight concentrated on

Fig. 3. Implement carrier with mid-mounted forage harvester and side rake attached at the front. The cut crop is blown into a trailer hitched behind

the front axle, so that the weight is approximately evenly distributed on all four wheels when a load is applied at the rear. As in the case of the tractor and power-driven trailer unit, operation is possible under conditions when the standard tractor fails on account of inadequate adhesion, *e.g.* when carting beet from the field, on timber haulage, transport in hilly country, or on soft ground.

Saving labour

Mechanical equipment has taken a great deal of hard work out of many agricultural tasks and often completely replaces hand labour. Perhaps the best example of this is offered by the advancement in grain harvesting. The combine harvester is capable of clearing a field completely by combining several tasks in one machine, leaving the field ready for cultivation a few hours after cutting of the standing crop commenced. But even where the stationary threshing machine is used to deal with the stored crop in the barn, the labour requirement has been greatly reduced by the use of automatic self-feeds and bond cutters, as well as grain, chaff and straw conveyors. One-man operation is claimed for an outfit comprised of a chopper-blower, a finishing thresher and grain, chaff and chopped-straw conveyors. The operator feeds the sheaves into the chopper-blower, where most of the grain is threshed out, the mixture then passing to the specially designed thresher *via* a pneumatic conveyor (Fig. 4).

Since a high percentage of the working time on an average farm is taken up by loading and transport work, considerable labour savings are achieved by the use of conveyors, elevators and loaders. A combination of a hydraulic front loader and manure spreader not only speeds up the carting and spreading of manure, but also takes out the drudgery formerly associated with this task. Apart from its uses as a loader for manure, friable materials and green crops, the hydraulic front or rear loader is, with suitable attachments, also being employed for such diverse tasks as erecting tripods and racks, for hay sweeping, ditch cleaning, sack lifting etc. Similarly, the power lift is used for a wide range of implements and attachments ranging from transport boxes to kale cutters.

Fig. 4. The only operator required for this threshing outfit feeds the sheaves into the hopper of the chopper-blower in the foreground

In the farmyard, too, the daily recurring work associated with tending livestock has been successfully mechanised by the introduction of milking machines, mechanical cleaners, high-capacity feed grinders and mixers, forage conveyors etc. Changes in working methods, leading to the use of baled hay, straw, and recently also silage, similarly offer a saving in labour.

Conclusions

Because of the growing shortage of labour, particularly casual labour, and the steadily increasing wage rates, farmers all over the world are compelled to have recourse to mechanisation. Whether it is a down-the-row thinner for sugar-beet, a cotton picker, an irrigation pump, a hedge cutter, a ditch cleaner or a tractor-drawn crane operated by double-acting hydraulics, the use of machinery in various parts of the world is instrumental in raising output per man and per unit of area, and in improving living standards and working conditions.

This advance has been mainly achieved by combining several operations in one machine and by enabling one-man control of the tractor and tool. High-powered tractors and heavy machinery also enable land clearance and reclamation work to be carried out where it was hardly possible or economic before this equipment became available. In the majority of cases the agricultural engineering industry has been able to provide suitable machinery to meet the demands of farmers, and constant efforts are being made to improve designs. There have been marked increases in the application of hydraulics to farm machinery, ranging from hydrostatic transmission in tractors and motor mowers to hydraulic mower drive, threshing-drum speed adjustment, clutches, variable-speed transmissions and hydraulic raising and lowering of the share or lifting prongs of root harvesters, the cutting platform and reel of combine harvesters, etc. If present trends are an indication of future developments, it is feasible that the future medium-powered tractor will be in the form of an implement carrier with hydrostatic transmission and providing oil hydraulic power for operating a large range of equipment.

Photos : N.I.A.E.

Powling Process

One of the Silver Medal winners at the Royal Society of England Show was E. H. Bentall and Co. Ltd., Maldon, Essex. Their winning entry was the Powling process designed by the late W. T. Powling and his son, W. T. L. Powling. This machine extracts protein from *any* green material and enables farmers to produce their own feeding-stuffs on the farm and enables considerable reduction in imported concentrates, which costs the country over £43 million a year.

THE APPLICATION OF HAND-CONTROLLED TRACTORS IN UNDER-DEVELOPED AREAS

F. P. D. MOORE

The development of mechanisation on under-developed small farms has been closely related to the economic position and servicing problems applicable to each individual country. Once agriculture has been raised above subsistence level it is largely the qualities of the equipment distributor that determine the successful use of the walking tractor.

IN the mechanical revolution that has taken place in farming during the past decade or so, one of the most interesting developments has been the increasing use of the 6–10-h.p. motor cultivator by the world's small farmers. This type of mechanisation has probably offered more problems, both economically and technically, than either the introduction of the standard four-wheeled tractor or the heavy-duty crawler.

The hand-controlled tractor is primarily used on the small acreages, for which it was mainly designed, with the exception of its mass use in some large sugar, coffee and pineapple estates where the crop rows are too closely spaced to allow any other form of mechanisation, and in the larger nurseries and market gardens. Only with the smallholder owner of a single machine do the economic and service problems become apparent.

Economic factors

Taking the economic problem first, the two main considerations are capital expenditure and operating costs. To most prospective purchasers a piece of equipment of this size represents by far the greatest capital investment he has ever made and, without some financial assistance from official sources, he has little or no chance of buying a machine. Then there are widely differing operating costs. Petrol varies from roughly 7s. ($1) per gallon in parts of Asia to 9d. (10 cents) in Peru, yet where the fuel price is highest an agricultural labourer may only earn the equivalent of 22s. ($3) a month. Thus, with a man and team of bullocks ploughing an acre per day with a native plough, at a cost as low, perhaps, as 2s. 6d. (30 cents), the mere substitution of a mechanical equivalent at greatly increased costs would by no means be an advantage. Therefore the prerogative of mechanisation in such cases is that either the output of the machine is so great as to beat, cost for cost, that of manual or animal draught implements, or that an actual increase in production, by speeding operations, improved cultivations or by bringing otherwise unusable land into cultivation, is effected.

On the credit side it must be said that mechanical cultivators can in most cases do better work than traditional implements; for example, the rotary cultivator may prepare a seedbed in one operation as opposed to perhaps nine ploughings with a native bullock plough. Also, the powered machine has a working speed to which the operator must keep. Labour may sometimes sound cheap, but in terms of output it can often be surprisingly expensive.

A Rotary Hoe 'Gem' used in a pineapple plantation in Australia

Servicing problems

Undoubtedly, the supply of spare parts and service constitutes the biggest difficulty, and the cost is bound to be considerably higher than in the country of manufacture. Obtaining spare parts from the factory may mean many weeks' delay and tragedy for the owner.

To the dealer, who naturally does not wish to tie up an undue amount of capital in spare parts, the problem is very difficult. He must stock sufficient spares and yet, in a relatively inexpensive machine, the profits on sales may barely justify the investment. Basically, therefore, for a machine to be successful from his point of view,

he must sell it in reasonable quantity, obtain a profit which may be two to three times that of a home dealer to cover his greater overheads and investment, and hold sufficient spares to maintain the reputation of both himself and the manufacturer.

Based on these assumptions, we should not expect to find machines of much less than, say, half the ex-works value of a medium-power tractor in regular sale in the more primitive countries and so far that seems to be the case. Any smaller or cheaper machine would hardly carry the charges of providing the necessary service.

Turning now to the type of equipment applicable to world-wide conditions, we find that in the walking-tractor class the rotary cultivator has largely ousted the pure ' two-wheeled tractor ', though plough attachments and other extra equipment are desirable in some areas, more particularly in temperate climates. This has come about largely for two reasons: first, that the rotary cultivator's ability to do the desired work in one operation means a greatly simplified task for both operator and equipment dealer, who would otherwise have to stock attachments; and, secondly, that if a man needs to reproduce the work of animal draught implements, *e.g.* using a cultivator to perform the work of a native plough, he must do it at such a speed as to make it economical. In fact, he must ride and not walk. There should be, therefore, a market for a very simple, cheap, but efficient riding tractor, without the refinements of present-day standard models, which can take multiple implements similar to those which the native farmer is accustomed, and cultivate at a rate that can compare economically with his draught animal output. So far manufacturers do not appear to have investigated this market very deeply.

Suitability

The rotary cultivator, however, is well established and that it is fulfilling a useful purpose must be accepted, since the demand has been increasing over a number of years. Its role, of course, varies from country to country. In Malta, for instance, it is in almost universal use in the farmers' small fields for the general cultivation of such crops as potatoes, corn and vegetables, whereas in Costa Rica the widest application is in the small as well as the large coffee farms, and in Siam it is mostly to be found in rice paddy.

A hand-controlled tractor used to control weeds in Malaya

Throughout the world most peasant holdings consist of small plots of land, broken either by irrigation ditches or by the nature of the ground. Here the advantage of the rotary cultivator is well shown in its ability to cultivate the last inch of land in these plots. Furthermore, its ability to return to the soil the stubble and crop residues makes a noticeable contribution to soil structure and fertility.

In the more tropical areas, burning of residues and vegetation to clear land is common practice, since better methods of utilisation are unknown. It is also frequently reported that the moisture-retaining properties of a seed-bed prepared by rotary tillage are of great value in areas where rain or irrigation water is scarce. It is these qualities that can turn the scales in favour of mechanisation.

Displacement of animals and manure

As animals are displaced there is, of course, less manure but proportionally more land available to support the human population. Although in many areas the regrettable practice of burning dung is widespread, it is, in general, used as the main fertilising agent where fertilisation is considered at all. Therefore it is essential that if manure is to become scarcer the incorporation of crop residues is more necessary than ever, whether or not chemical fertilisers are employed in addition. There are signs that there is now some appreciation of this problem and in a few instances green manure crops are being specifically grown.

Turning point

The advances of mechanisation are naturally much slower in the over-populated countries, where agricultural land itself is scarce. In the arid countries big irrigation schemes precede normal farming operations and some time may elapse before the small-holdings themselves are ready for the profitable use of machinery. And yet we find in some densely populated areas, where the standard of living is higher, the small machine is an economic necessity. The turning point appears to be when a farm becomes more of a business than a subsistence holding.

In many areas it is not shortage of land nor lack of facilities that prevent development, but the almost total

Cultivation of cassava in Siam

absence of a profitable market. In a small country like British Honduras, for instance, the planting of an extra few acres of potatoes or raising a few thousand more laying hens can practically flood the market, yet insufficient quantities could be produced initially to warrant an export trade. Mechanisation is needed to enable the small farmer to produce the necessary quantity and thereby raise his own standard of living.

The rotary cultivator is ideally suited for any row-crop work such as pineapple, vines, coffee, tree nurseries and, of course, vegetable crops. One manufacturer makes a special model for use in wet rice, where the mechanical action of the blades is greatly superior in destroying weeds and in puddling the soil than existing methods, thus making the operation economical and efficient.

Financial assistance

In various countries government agricultural departments have financed the purchase of considerable numbers of machines, which they release on long-term credit to smallholders, particularly in resettlement schemes, and they appear to have chosen this type of machine with two objects in view: first, that it is robust enough to cultivate land that may only recently have been cleared of jungle and may still contain some undergrowth and roots; and, secondly, that a single unit, without complicated attachments apart from perhaps a furrowing attachment for drawing out drills or irrigation channels, and a belt pulley, is more suitable and easier from an administrative angle than a powered two-wheel tractor with a multiplicity of implements. This is not to say that seeders, cutter bars, sprays etc. are not to be desired, but in schemes of this nature and when dealing with farmers having their first introduction to mechanisation, the capital cost of such equipment is often too high for the relatively small amount of specialised work he has to do. In all cases the actual tillage work represents by far the greatest single chore and it is to this end that present-day machines are most usefully employed.

Importance of dealer

The success or failure of small-scale mechanisation in any particular country has been, in fact, more closely related to the qualities of the distributors and dealers than to the needs of the country. Wherever a distributor is found who will not only give spares and service a high priority, but also gives good instruction to the operators, mechanisation has been successful, but where the dealer has been either so big as to consider the whole thing an insignificant sideline, or so small as to find the handling of anything motorised beyond his resources, there has sometimes been dismal failure and much discouragement to the unfortunate user. Manufacturers might well consider the advisability of giving long-term credit on spare parts rather than machines, provided their overseas distributors stock the manufacturers' recommended list. It is unfortunately a fact that government departments themselves are often the worst offenders for considering provision for spares, yet any large orders should contain a percentage of spare parts if the department is not to fail its customers.

Future prospects

Looking to the future, it is not easy to be dogmatic as to what the ultimate trend of the miniature tractor will be. As mentioned above, if a man can ride he does not wish to walk, yet it is difficult to design a riding tractor with the necessary ground clearance that will cultivate between the inevitable rows of the smallholder's crops without losing its stability, and a large proportion of peasant holdings are on hillsides. The rotary cultivator has come to stay as almost the only mechanised equipment of its size that can tackle the vigorous tropical growth which can so quickly smother the land, yet it is considerably more complicated a machine than the rigid tined cultivator, which may be not only adequate, but preferable in arid land areas. With the cost of petrol generally high and the often doubtful qualities of local kerosene, the diesel engine should be an obvious advantage, yet the close proximity of the engine to the dirt and dust of cultivation raises great problems of fuel and air filtration and maintenance for which the primitive farmer is ill equipped.

Therefore, since the machines available in present design are generally proved and reliable, it seems doubtful if any radical change in tendency of design will appear, and the chief problems are those of mechanical education and practical application. The most hopeful sign is the way, even in the most unexpected parts of the world, that men are taking to these machines.

Photos: Rotary Hoes Ltd.

MECHANISATION OF FARMING IN THE COLONIAL TERRITORIES

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Attention has been drawn[1] to the suggestion that 'economic' mechanisation must depend upon the use of standard, or near-standard, quantity-produced equipment. Cheapness and versatility are also important. Specialised local requirements can rarely be met with machinery which is sufficiently cheap, versatile and supported by spare parts and service facilities. Progress in introducing modern quantity-produced equipment into tropical agriculture has been reviewed with particular reference to Central Africa, East Africa and the High Commission Territories following a fact-finding tour in 1953. The present paper is based on a similar tour in West Africa.

DURING April–July 1954 the writer visited the Gambia, Sierra Leone, the Gold Coast and the three regions of Nigeria under the auspices of the Colonial Agricultural Machinery Advisory Committee and with the very helpful co-operation of the territorial governments. A mass of information was collected (much of the detail concerning the mechanical performances of machines), from which the following general conclusions were drawn:

(*a*) There will be little expansion of agricultural mechanisation in the Gambia for several years. Sierra Leone may develop very big plans for rice production on inland swamps and riverain grass-lands. In the Gold Coast there is great popular interest in mechanisation and the whole subject is being investigated very thoroughly by the Government and the University College, but the difficulties are considerable. In Nigeria interest is concentrated on rice production and general tractor ploughing, and noteworthy progress is being made at the agricultural engineering headquarters in the Northern Region. Disappointments have been experienced in several commercial mechanised agricultural production schemes.

(*b*) There would be considerable interest in bulletins on tropical agricultural engineering. Such work should not be limited to matters of strictly British territorial interest and should be in an authoritative permanent form to facilitate cataloguing and storage.

(*c*) Considering the difficulties of local conditions, the territorial departments of agriculture are to be congratulated on the extent of the experience of mechanisation which they have gained in a comparatively short time.

(*d*) Skill and experience in management can be much more important than technical skill, especially in colonial conditions.

In addition, the general conclusions drawn[1] after the visit in 1953 to eastern and southern Africa were endorsed in relation to West Africa, although the immediate requirements of the African farmers for agricultural machinery were found to be much less than in eastern and southern Africa. This is due, presumably, to the absence from British West Africa of a community of settler farmers or plantation companies from whom the indigenous population might have gained much technical knowledge by observation and example.

Cost of machinery operations

The high cost of machinery operations, described in some detail in the previous paper, appeared to be even more significant in West Africa, mainly because the farming is less developed commercially than in eastern and southern Africa, skilled mechanics are not so readily available, and spare parts are not so easily distributed.

Tractor running costs. It was difficult to reconcile various estimates of running costs made by different authorities. The basis and significance of cost accounting was not understood on several stations or projects. Cost accounts were often based upon a log-book record only. The use of tractor-hour counters, or rotating chart recorders was not widespread. In some costings no allowance was made for overhead expenses; in others no provision was made for replacement; and in yet others the full costs of repairs, buildings and supervision were being charged as they arose. Some misleading figures had been publicised by commercial interests in the Gold Coast in which no mention had been made of repairs, parts and capital costs. It was also not fully appreciated that a charge for 'depreciation' can only cover *either* the repayment of capital, *or* the replacement of the machine, but not both.

Figures intended to indicate the cheapness of mechanical operations are likely to be misguided. Better ends would be served by emphasising the possibilities of increasing production, and thus profit.

Low crop yields

Extremely low crop yields were being experienced on many projects. On some the records indicated that mechanical operations would become economic if yields were increased threefold. Such increases would not be inconceivable, but exhaustive agronomic investigations would be necessary. More might be discovered about the effects of crop residues and green manures on the nutrient state and mechanical condition of the soil, as compared with chemical fertilisers and mechanical treatments, such as sub-

soiling. The whole field of trash farming would be worth investigating in the savannah areas. Fertiliser treatments are already being investigated widely and problems of mechanical placement are receiving some attention. In some areas it may be necessary to investigate the difficulties of transporting, storing and marketing increased quantities of produce.

Manufacturers agents

The remarks under this heading in the previous paper[1] apply equally in principle to West Africa, although the whole trade in agricultural machinery is much less than in East Africa, and the problems associated with dollar area goods are less acute. In the Gambia and Sierra Leone there is no really effective agricultural machinery agent, because the trade is negligible at present.

Technical progress

Paddy cultivation. Most of the development of paddy growing in West Africa has taken place on inland swamps and natural flood plains without means of water control. Tractor adhesion problems are associated with extremely dry soil as well as wet. Mechanical operations are directed towards *either* small-scale ploughing for peasant producers, *or* large-scale ploughing and, possibly, drilling of seed for peasants. Particular mention should be made of the Gambia Rice Farm, where paddy-growing techniques are being thoroughly investigated with an extensive irrigation system, the dry-season cultivation of inland swamps and riverain grass-lands in Sierra Leone, where the Department of Agriculture ploughed about 8,000 acres in 1954, and the Sokoto fadama-ploughing project, at present under administrative reorientation, which achieved no less than 37,000 acres in its peak year.

A recent survey[2] of rice soils in the British colonial territories showed that there were two main types in use:

(*a*) *Clays*, in which a relatively firm ' bottom ' can be found at a depth of 6–12in.—at least at the beginning of the season;

(*b*) *Silts and silty sands*, in which no firm ' bottom ' can be found near the surface once the land is flooded.

The *peats* vary greatly in their characteristics, but usually have a surface mat of organic matter which, if unbroken, can bear a considerable distributed weight. Very little use is made of them for rice production. It is possible that they will become more important as populations increase.

Many of the rice soils in West Africa appear to be of type (*b*) and if the water rises early in the season all mechanical work may be halted long before the normal planting date. If mechanisation is desired, it will be necessary either to increase the number of controlled irrigation schemes or to investigate the possibility of using long-standing varieties.

African labour is readily adaptable to mechanised techniques

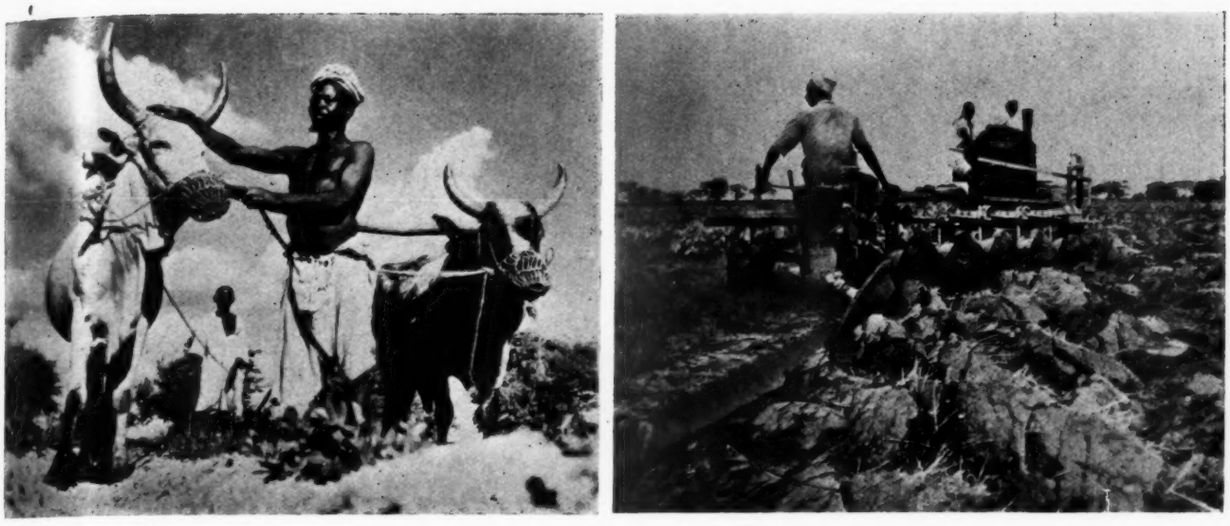
Current thought on methods of obtaining adhesion and traction on paddy land have been reviewed elsewhere[2] and a new commercial development has been described which gives the tractor stability and flotation by cage-type extensions to the standard pneumatic tyre equipment. The extensions, about 12 in. wide, are slightly less in diameter than the tyres so that road travelling is not affected. The tractor can be fitted with a hydraulic depth-controlled mounted disc harrow and levelling board combination. Reports received from India have justified the production of a large consignment of this equipment.

It is possible that cable-haulage tackle could be developed for use in some very flat areas (such as delta soils or mangrove swamps) where large paddy fields could be laid out on the square and the intervening bunds could be made wide enough to accommodate compact power units. At least one machinery manufacturer is prepared to co-operate in any such project.

Paddy harvesting. Self-propelled combine harvesters are working successfully in one or two places in West Africa, but they are rare because they are expensive and can only be economical when a considerable acreage is harvested each year. For a 10-ft. combine harvester 150 acres or more might be economical, depending on the length of harvesting season. Potential customers are reluctant to buy a machine requiring considerable experience in handling and maintenance.

A new trailed combine harvester of 4-ft. cut, power take-off driven, is being adapted for use in paddy. Trials were to be held in France in October 1954. The combine will be fitted with a peg drum, peg concave, and balloon tyres. Harvesting equipment which has recently been used elsewhere includes a tractor-mounted head harvester (Malaya), a tractor-mounted power-driven binder (Italy) and a reaper-type mower with a manually operated sheaf board which leaves the loose sheaves on the ground to be tied by hand. While the latter is not considered to be a final answer to the rice harvesting problem, it might possibly meet a current requirement in parts of West Africa.

Brush and weed control in perennial crops. The use of machinery in the



A recent comparison of old and new farming practices in West Africa. (Left) *A farmer of Kafinsoli, Northern Nigeria.* (Right) *Mechanical land cultivation*

production of established export crops appears to be the most logical starting point for mechanisation in the agriculture of any territory, but oil palms and cocoa are seldom planted or tended in such a way that mechanisation of field operations would be possible. It is, nevertheless, interesting that trials of bush-cutting machines are starting at the West African Institute for Oil Palm Research, Benin City. The problem is to control underbush in plantations without disturbing the soil. In the early stages stumps and logs remain on the land, but in later years the bush consists largely of grass, vines and some small shrubs. A rotary cutter and a duplex roller cutter are now in use. No British machine is available at present, although one is said to be in development. Similar work has been done in the Belgian Congo.[3]

Palm-nut cracking. Excellent results are reported to have been obtained in Sierra Leone following the development of a small engine-driven palm-nut cracker which has now been put into commercial production in the United Kingdom. Trial units have been sent to the Gold Coast.

Land clearing. There is considerable difference of opinion about bush-clearing methods. The tendency at present is to do the job by hand, or with small mechanical aids, and to develop the land slowly, possibly even planting and cultivating by hand during the first year or two. Complete clearing and logging of wide areas by tractor is likely to be expensive and dangerous from the point of view of soil conservation, and yet it is possible that undue emphasis is put upon the dangers of disposing of bush by burning. Reports from the Belgian Congo indicate that a small degree of mechanisation in clearing forest may lead to the saving of labour, but no immediate economic advantage has been demonstrated.

It appears that special mechanical arrangements for clearing mangrove swamps may not be necessary in West Africa. Even where the demand for mangrove land is considerable, hand-clearing methods appear to be quite adequate for agricultural purposes. In some areas individual farmers preferred to clear new land by hand rather than compete with sedges and grasses on the old land.

Summary

This paper enlarges upon some of the conclusions drawn after visiting West Africa to see progress in the mechanisation of agriculture. Several general conclusions drawn following a visit to East Africa during the previous year were endorsed in relation to West Africa. The cost of mechanisation is emphasised, particular mention being made of the importance of record keeping. Some technical developments are reviewed briefly.

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HYDRAULIC BAG-LOADING MACHINERY

Following a recent inquiry, the staff of WORLD CROPS *undertook a survey with the purpose of establishing what countries could make use of imported hydraulic bag-loading machinery. The answers to the questionnaire have been tabulated and are shown in the table.*

Should manufacturers of equipment of this type feel that they would like to have more information on the subject we shall be glad to refer them directly to the relevant source. All inquiries should be addressed to 'The Editor, WORLD CROPS, 9 Eden Street, London, N.W.1, England'.

POTENTIAL USE OF BAG-LOADING MACHINERY WITH SPECIAL REFERENCE TO GRAINS, SUGAR, TEA AND RUBBER

Country and crop	*Form in which transported*	*Transporter*	*Possibilities for hydraulic bag-loading machinery*
ARGENTINA			
Grains	(*a*) Bagged from farms to warehouses (*b*) Bagged or bulked from storage points to ports	(*a*) Producer (*b*) Usually by State Commercial Agency	Depends upon individual machine
AUSTRALIA			
Wheat	Mostly bulked	Producers to warehouses	Not very great
Barley	Bagged		
Maize and oats ..	Mostly bagged		
Rice	Mostly bagged		
Sugar	Bagged		
Fruit	Crated		
CANADA			
Wheat and other grains	Mostly bulked	Producers to warehouses; then controlled by Canadian Wheat Board	Possibly great
EAST AFRICA			
Wheat	Bagged	Producer	Good
Tea	Boxed	Planter	
IRAN			
Cereals	Bagged	Landlords and merchants	Poor
Tea	Boxed		
Sugar	Boxed		
IRAQ			
Various	Mostly bagged	Contractors	Poor
JAPAN			
Wheat	Bagged	In the hands of Government contracting firms	Depends upon individual machine
Rice	Bagged		
Tea	Tea chests	Dealers	
MALAYA			
Rice	Bulked or bagged	To mill by producer; from mill by merchants	May be possibilities
Rubber	Self-baled	Planters	
NEW ZEALAND			
Grain	Sacked and bulked	Producers and contractors	May be possibilities
PAKISTAN			
Wheat	Bagged in gunnies	Producers and contractors	Poor
Rice			
Sugar			
Tea	Crated		
SOUTH AFRICA			
Maize and wheat ..	Bagged and bulked	Producers to the railhead, etc.	
TURKEY			
Sugar	Bagged or crated	First by producers, then by a semi-Governmental organisation (Türkiye Teker Fabrikalari A.S., Ankara)	Poor
Cereals and pulses ..	(*a*) To a semi-Governmental organisation in bags (*b*) Usually bulked	(*a*) Producer (*b*) By Toprak Mahsulleri Ofisi, Ankara	

TECHNICAL DEVELOPMENTS IN CRANKCASE LUBRICANTS FOR TRACTORS—I

E. S. BATES, A.M.I.MECH.E., M.I.B.A.E.

This article is condensed from a Paper presented at an Open Meeting of the Institution of British Agricultural Engineers earlier this year.

THE purpose of lubrication is to prevent metal to metal contact. The ideal lubricant must, therefore, be sufficiently viscous to keep these surfaces apart without, at the same time, causing starting difficulties by requiring a high starting torque to overcome the oil drag in the crankcase. Therefore, the oil has to remain stable under changing temperature conditions. Besides this the lubricant is expected to keep metallic parts clean and not to corrode metallic surfaces. A properly refined lubricant fulfils these requirements.

Crankcase oils

Mineral oil in its original state is crude oil. Before the advent of modern refining methods and the use of additives, the source of the crude oil was of some importance. For instance, those classified as naphthenic lubricants evaporated quickly on hot cylinder walls and piston ring lands, leaving behind them little carbon; and the paraffinic lubricants did not thicken as much as the other at low temperatures, if properly treated, and were therefore very suitable for tractor engines, which have to be started out of doors in cold weather. However, the manufacturer of lubricating oils today employs several new methods of refining by which the oil from most crudes can be stripped of its unwanted components and produce in the end the required balance between naphthenic and paraffinic bases. Most modern lubricants of today are, therefore, of mixed base and the introduction of additives completes the process of making the source of the crude of minor importance.

The correct viscosity

The first thing we have to consider when selecting crankcase oils is, therefore, the S.A.E. number, as the S.A.E. number gives us some idea of the viscosity of the oil. If the oil is too viscous, the engine will not be able to start; if the oil is too thin, the crankshaft bearings may be damaged and most certainly the oil consumption will be increased. To prevent an error of this sort the tractor manufacturer issues an S.A.E. number recommendation for each type of operation, winter and summer, in arctic temperature and tropical climatic conditions. A study of tractor manufacturers' recommended grades classifies those most commonly specified in Table 1.

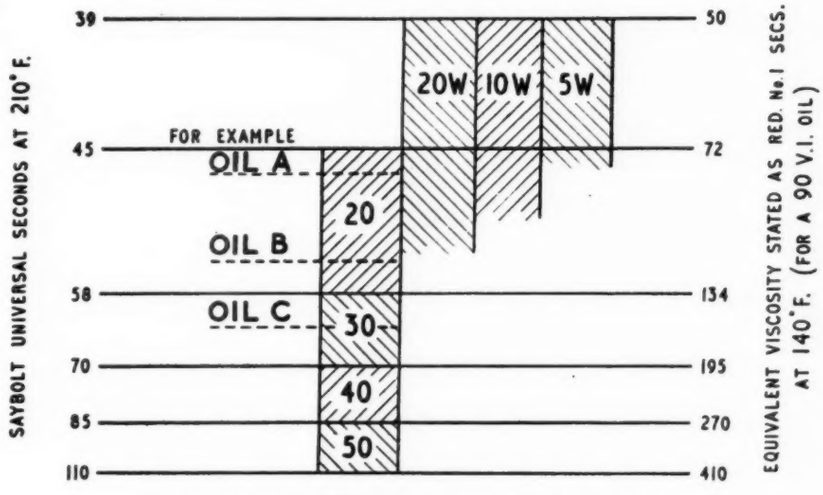
The variation of grade in each classification is due to differences in engine design and operating condition as between diesel, gasoline and vaporising oil. There are also differences between tractor manufacturers employing the same type of engine, indicating a degree of opinion rather than factual assessment in these recommendations. For the owner having different makes of machine on the farm, this confusion is detrimental and new developments in crankcase oils are designed to clear this up. The S.A.E. classification is arranged to give a

TABLE 1
TRACTOR MANUFACTURERS' CRANKCASE OIL VISCOSITIES RECOMMENDATIONS, 1954*

	Winter S.A.E. Nos.	*Summer S.A.E. Nos.*
Northern climate	Diluted & 10W	10W–30
Temperate Zone (U.K.) ..	20W–30	20–40
Tropics	20–40	30–50

* Inclusive diesel, gasolene, vaporising oil.

TABLE 2 SAE NUMBERS - VISCOSITY BRACKETS



WINTER OILS AT 0° F. SHALL HAVE VISCOSITIES:—

(A) 5W NOT GREATER THAN 4000 S.S.U.

(B) 10W LESS THAN 12,000 S.S.U. BUT NOT LESS THAN 6,000 S.S.U. UNLESS THE VISCOSITY AT 210° F. IS NOT BELOW 40 S.S.U.

(C) 20W NOT GREATER THAN 48,000 S.S.U. BUT NOT LESS THAN 12,000 S.S.U. UNLESS THE VISCOSITY AT 210° F. IS NOT BELOW 45 S.S.U.

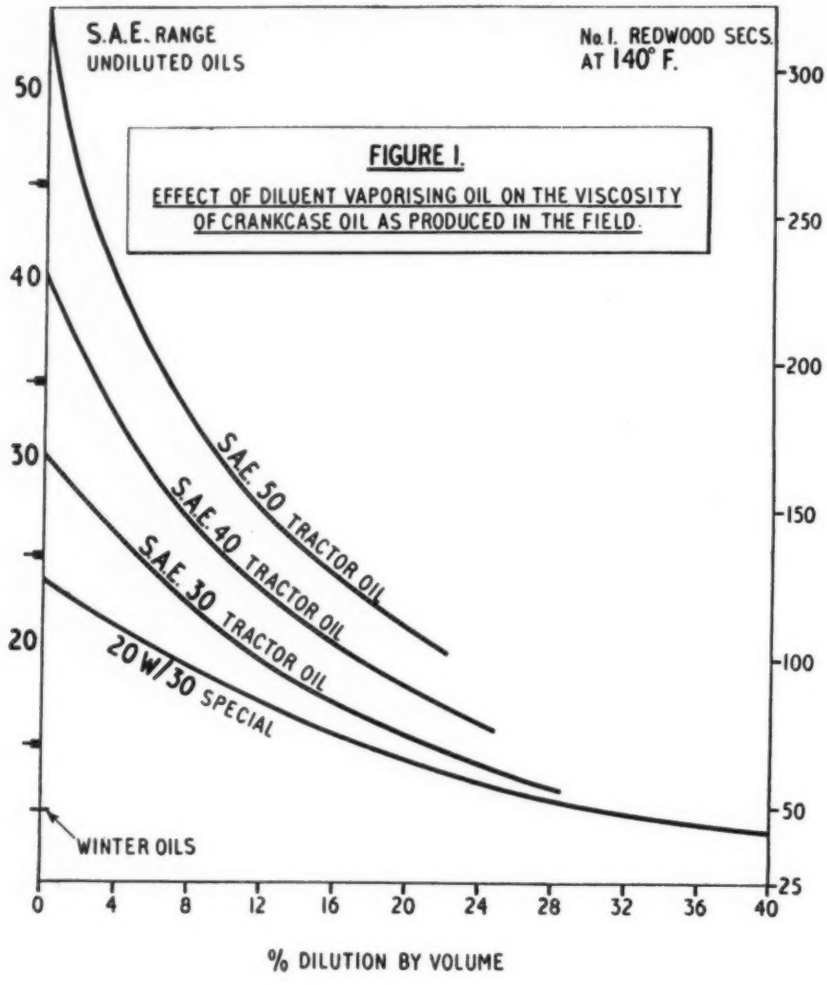


FIGURE 1.

EFFECT OF DILUENT VAPORISING OIL ON THE VISCOSITY OF CRANKCASE OIL AS PRODUCED IN THE FIELD.

general idea of the thickness of the oil we are dealing with, and it can be visualised in Table 2.

An S.A.E. 30 oil, for example, is any oil which, measured by viscometer at a temperature of 210° F., is found to have a viscosity falling between 58 Saybolt Universal seconds and 70 Saybolt Universal seconds; and likewise for the other S.A.E. numbers. Two series of viscosity figures are shown because this classification is American in concept and it is, therefore, necessary to include American units in Saybolt seconds. The second scale of Redwood seconds at 140° F. is included because it has been customary for us, in the past, to use this temperature viscosity relationship in comparisons between new and used lubricating oils, upon which much of the present-day technical developments in crankcase oil quality depends. A temperature of 140° F. also represents a year-round average for crankcase-oil temperature in this climate and field experience indicates the minimum acceptable viscosity at this temperature required to provide safe lubrication. For the most part, oil companies blend their oils to a given S.A.E. number so as to provide a viscosity near the middle of the bracket. It can readily be appreciated that oil viscosity affects engine internal friction. Hence, owing to the spacing of the brackets, whereas oil B is an S.A.E. 20 grade, it would hardly be distinguishable in service from oil C, which is an S.A.E. 30 grade; but oil A, which is also an S.A.E. 20 grade, will give easier starting than oils B and C (Table 2).

'W' is a symbol of winter quality and the viscosity at 0° F. is included because there is a maximum oil viscosity beyond which an engine will not start due to oil drag, *e.g.* 20,000 S.S.U. It is not possible to be definite about this, because starting in cold weather depends so much on the state of the engine and battery, the compression ratio of the engine and the design of the combustion system. However, to give some idea the figures in Table 3 may serve as a guide.

The reason why some manufacturers of vaporising oil tractors continue to specify a relatively high S.A.E. number is because of crankcase dilution, the effect of diluent on oil viscosity being as shown in Fig. 1. As the fuel diluent in the crankcase is not exactly the same as vaporising oil in an unburnt state, dilution viscosity charts as made up in the laboratory are not strictly accurate. The information given in Fig. 1 is obtained from field experience with vaporising oil tractors and it will be seen that the depressant effect of diluent on viscosity diminishes as the amount of diluent increases. This field research has shown that a figure of 50 Redwood No. 1 seconds at 140° F. (Fig. 1) can safely be accepted.

Viscosity index

It will be seen from Table 2 that the scale of Redwood seconds at 140° F. has attached to it the symbol 90 V.I. Viscosity index plays an important part by ensuring sufficient viscosity to prevent lubrication failure at temperatures higher than 140° F. (*e.g.* temperature of the oil film in a tractor crankshaft bearing will be about 270° F.), at the same time permitting the oil not to be too viscous at a low temperature.

The meaning of viscosity index with respect to high temperature and low temperature operation is illustrated in Fig. 2 by selecting two oils with similar viscosities at 210° F. (This is not necessarily the case in practice, but it is a convenient means of indicating what V.I. means to the user.) V.I. depends to a large extent on the nature of the crude oil and subsequent refinery treatment. There are, however, additives known as viscosity index improvers which can be compounded with mineral oils to improve their characteristics as shown in Fig. 2. Having studied Fig. 2, the reader will

TABLE 3

If using S.A.E. No. oil	*Air temperature before starting should exceed*	
	(*a*)	(*b*)
40	30° F.	40° F.
30	15° F.	25° F.
20W	5° F.	15° F.
10W	−15° F.	−5° F.

(*a*) Spark ignition. (*b*) Diesel.

quickly see for himself the value of a high-viscosity-index oil in tractor operation, which can go to both extremes, *i.e.* high crankcase temperature on belt work in and around farm buildings, where air movement may be blanketed, and low-temperature starting outdoors in winter.

Pour point

Naturally, the pour point of an oil must be sufficiently low for the climatic condition involved, and there are additives as pour-point depressants to assist this necessary feature. The determined pour point has to be at least 14° F. lower than the lowest expected air temperature to ensure oil flow without heating.

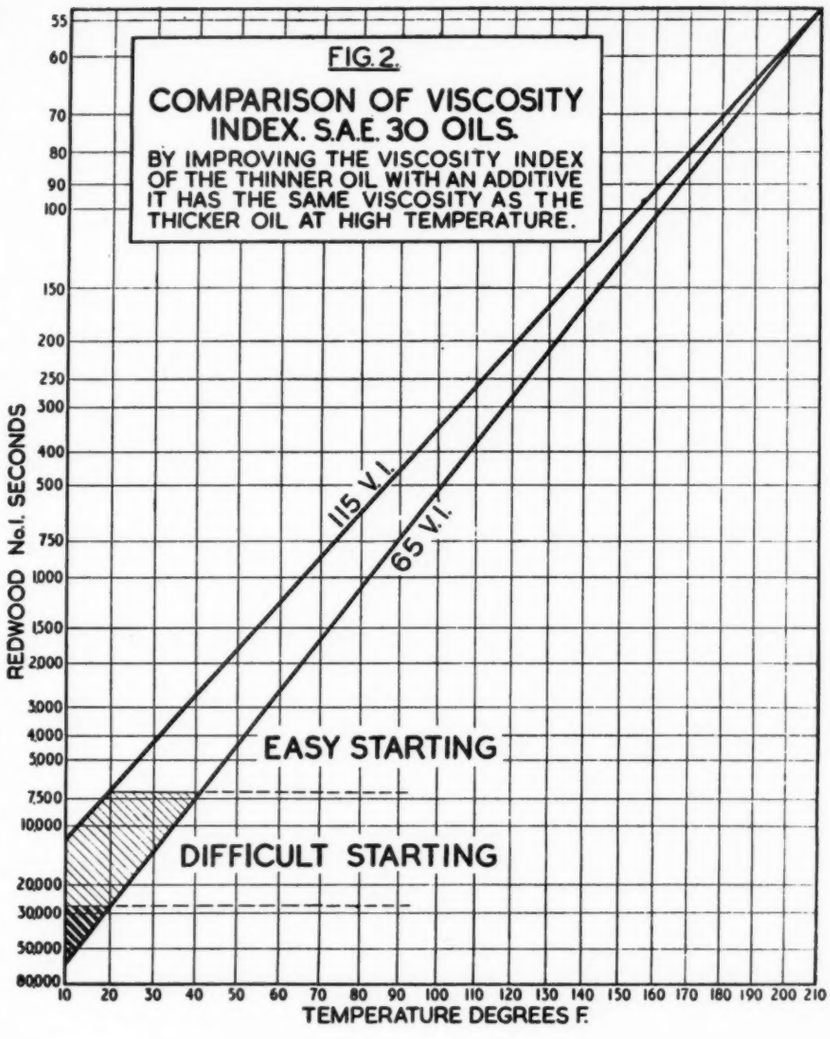
Additives

Small percentages of various oil-soluble materials are often added to mineral oil to impart those characteristics which are not readily obtainable by refining processes. These materials are given the name 'additives' and there are several types, as shown in Table 4, which is confined to the additives employed in heavy-duty lubricating oils. Other additives are available for improving the characteristics of hydraulic or mechanical transmission oils and greases.

The colour of an oil, which at one time was an indication of the quality of the base stock, is no longer significant. Advances in refining technique and the use of additives have made such approximations quite impracticable.

Use of additives

The life of piston rings and cylinder liners is determined by corrosive wear and abrasive wear. Corrosion is most important after engine shut-down at low temperature coupled with low-temperature starting. Oil additives, in combination, can lessen corrosive wear by preventing combustion acids from reaching the metal surfaces when the engine is stationary and, in addition, by neutralising them when the engine is running. Start-up wear is the major part of engine wear under normal conditions and this emphasises the importance of surface protection of engine parts during the shut-down period. Additives also have film-strength - improving characteristics which are readily noticeable over and above the straight mineral oil, *i.e.* an oil without additives.



Abrasive wear caused by dust in the intake air, dirty fuel getting past the fuel filters (though this should never happen) or improperly machined surfaces, are factors which must be left entirely to the engine designer. Mild abrasive wear due to worn material from the piston-ring and cylinder-liner surfaces being entrapped by lacquers on the piston surface can, however, be entirely eliminated by the use of detergent-dispersant additives in sufficient quantity in the lubricating oil. These additives prevent the agglomeration of microscopic particles of combustion soot and oil breakdown products, thus preventing lacquers from forming on the piston surfaces. Without detergent-dispersant additives, in time sufficient oil breakdown and combustion products will accumulate in the piston-ring grooves to prevent the proper functioning of compression rings and scraper rings. Depending on the amount of additive present in the oil and the frequency with which the additive concentration is replenished, either by topping up or oil changing, the time obtained before piston ring renewal is needed is increased from 1½ to 4 times.

Corrosive wear, which was mentioned above, is largely dependent on the temperature of the cylinder walls, which should be maintained at temperatures over 130° F. to prevent water, which is a product of combustion, from condensing on the cylinder walls. The products of combustion absorbed by condensed water form acids which corrode cylinder walls, thus causing wear. Cold starts or continuous light-load operation are thus the most frequent source of corrosive wear, and can be avoided by employing a suitable warm-up technique and use of thermo-

stats to prevent the cylinder water temperature from falling below 140° F. However, as a tractor has to work under any circumstance that may arise on the farm, it is more often than not impossible for the farmer to pay attention to this, and the amount of heat developed by the engine in the first place may be insufficient to raise the water temperature high enough. With this in mind, the modern development of additive-type oils is to ensure positive alkalinity in the compounded oil to offset the effect of acidic combustion products, and, of course, the greater the quantity of additives of this sort that are employed the more likely it is that corrosive wear will be prevented.

Ring sticking, a diesel-engine complaint, can be caused by blocking of the piston-ring grooves with oil breakdown and combustion products preventing the free movement of the ring. Most often it is found that ring sticking is confined to the upper compression rings, and this is quite natural, since they run at the highest piston temperature, and lubricating oil at this point is more readily destroyed. When the additive-type oil has been in use for too long a period, the total quantity of combustion soot and oil breakdown products is greater than the initial additive charge can deal with, so that agglomeration and deposition begins in the hottest part of the engine. Below 375° F. ring sticking is not likely to be a problem, but experience has shown that there are very few diesel-engine designs today which do not require the use of an additive-type oil if really long periods between piston ring renewals are to be expected. Ring sticking can also be due to light-load operation, causing fuel varnish deposits on the cooler parts of the pistons, for instance the scraper ring. Blockage from this source is a most frequent cause of increase of oil consumption. Once again the use of detergent additives is recommended to prevent this from occurring.

Another sort of objectionable product so often seen in diesel and spark-ignition engines in the past is that of sludge. Once again due to the nature of many farming operations, consistent cold running of an engine produces combustion acids and water, which condense in the crankcase due to the lower temperature. Water acids of this sort, violently agitated with the oil in the crankcase, produce sludges which tend to settle down in the coolest part of the engine, *e.g.* the top cylinder head deck or the valve covers of side-valve gasolene engines. Direct water leaks into the oil system are another cause of sludge formation. The effect of additives is to disperse these oil–water sludges throughout the oil so that at the oil change period they are effectively extracted from the engine.

Under conditions when the combustion is poor—as, for example, in diesel engines with badly calibrated injection equipment or in gasolene and vaporising oil engines with over-rich fuel/air mixtures—an oil-carbon sludge is formed and if sludge of this sort strikes a hot spot it becomes oxidised, particularly if an oil of heavy-duty type, *i.e.* one with additives, is not being used.

TABLE 4

Additive type	*Compounds used*	*Action of additive*	*Results of use*
Antioxidant ..	Organic compounds containing sulphur, phosphorus, nitrogen. Metals sometimes incorporated, *e.g.* barium, tin and zinc.	Retards oxidation of oil by preferential oxidation of the additive, thus reducing formation of organic acids.	Prevents deposits of varnish and corrosion of copper lead bearings at high-temperature conditions.
Detergent ..	Metallo-organic compounds, *e.g.* phosphates, phenolates, metallic soaps, containing barium, tin.	Prevents oil-soluble oxidation products of oil from becoming insoluble by means of chemical reaction.	Prevents sludge deposits of all types, thus keeping internal engine surfaces clean.
Dispersant ..	Metallo-organic compounds, *e.g.* naphthenates and sulphonates. Organic salts containing calcium etc.	Peptises, *i.e.* maintains in a finely divided state the minute particles of combustion soot and oil decomposition products.	Prevents agglomeration of these products, thus preventin carbon deposits ing ring grooves, on piston skirt, etc.
Viscosity index improver ..	Polymerised olefin. Cellulose esters.	Being less sensitive to temperature than oil. . . .	. . . the rate of change of viscosity with temperature of the oil is reduced.
Pour-point depressant ..	High-molecular-weight polymer of hydrocarbon obtained by condensation.	Prevents the growth of wax crystals in oil at low temperature.	To lower the pour point of oil.

Filtering additive oils

Filtration of lubricating oils is strongly recommended, especially for tractor duties. Not only does it provide a safeguard against contamination, but in the event that oil is used for too long a period, so that breakdown products begin to agglomerate, the filter is there to remove them and prevent their depositing on the hot surfaces of the engine. The detergent-dispersant additives in a fresh oil, however, assist the passage of these microscopic breakdown products through the oil filter element. However, this need be of no concern, because experience has shown that they are so small that they can do no damage to the engine. As the effectiveness of the additives begins to wear off, there is a tendency for agglomeration to occur and then the particle size of the agglomerate is such that the filter becomes effective. Most filter elements, however, in order to permit a reasonable flow of oil without inducing a high back pressure, have to have relatively large passages, *e.g.* 20 microns, and if it is seen that the filter is consistently covered with sludge and carbonaceous material, then it is an indication that for this particular condition of operation the oil change period is too long.

Oil change periods

Every engine manufacturer finds by experience the most suitable time for changing oil—it is well worth while adhering to the recommendation. Ignoring the recommendation and using an oil far beyond its effective life will

Continued on page 414

Harvesting rice near La Albufera, Valencia

The Increase of Rice Cultivation in Spain

FRANCISCO JIMENEZ-CUENDE

(*Director-Gerente*, Agricultura)

Señor Jiménez-Cuende, an agronomic engineer, has been managing director of our Spanish counterpart, Agricultura, *since its inception, more than 25 years ago. Thus he is in a position to give an authoritative account of the agricultural position in Spain today. This article will be followed at regular intervals by reports on the state of various crops, together with a description of the general agricultural economic position.*

ONE of the crops most deeply affected by the transformation of Spanish agriculture, mainly during the last years of the civil war, is rice. The many methods of intensive rice cultivation enable it to be considered as a new crop in irrigated areas. For centuries it has been confined to a few provinces of Levante, but is now being grown more and more in the interior. It is, for example, being cultivated in areas such as Huesca and Badajoz, which have no rice-growing history at all, and where 20 years ago it was entirely unknown.

Agricultural view

The fact that National Spain remained without rice lands at the beginning of the civil war was the main reason for encouraging rice growing in the Isla Mayor (Sevilla). This work presented great difficulties for the different companies which, at the beginning of 1927, dedicated great efforts to the cultivation of these swamp areas.

In these virgin lands rice growing was a success from the beginning. Although at first this was sceptically believed to be the fortuitous result of the conditions, it was soon seen that, given the adequate means at the end of the war, cultivation continued to increase.

Government control

To secure the cultivation of the marsh lands on a firm basis, Bills were passed with the purpose of consolidating the extension of production.

By a stroke of good fortune, the year 1945, which saw the publication of the law establishing regulations for rice-growing areas, coincided with the beginning of a period of five years' severe drought, during which it was necessary to demand a great agricultural effort to feed the population. Farmers did their best to get the highest yield from the soil. Among other methods it was decided to make use of salty and swampy soils, hitherto yielding poor pasture—in some places not even that, as these areas are infested with parasites causing infection of the sheep (mainly distomatosis).

By the benefits derived from the cultivation of rice, which in good lands reached 9,000 kg. per ha., with an average of 6,000 kg. of unhulled rice per ha., the rice fields began to extend, not only in the salty and marsh lands, but, encouraged by temporary author-

Spanish rice of the ' Bomba ' variety

isations granted to relieve the food crisis, and by the profits gained from the high prices, they overflowed into those waste lands that were difficult to till and reclaim. Cultivation was extended through the old irrigated fields which were not prepared to receive such a great quantity of water as is needed for this crop. This ruined the crops of adjacent lands, forcing them in their turn to rice growing. So it spread like an ugly stain, causing a decrease in agricultural products and bringing about the disappearance of olives and fruit trees scattered over the irrigated lands.

This situation of non-stop growing has been halted in recent years, as much as for the more normal production of food—especially wheat—as for the necessity of preventing the destruction of whole areas of old irrigated lands, which, on losing their tree plantations, would, when the rice consumption reached saturation point, remain in a ruined condition.

These limitations were established in official orders which, however, authorised temporary concessions for cultivation for a period of seven years provided the land fulfilled minimum conditions with regard to availability of water and salinity of the soil. At the same time it was necessary to restore certain lands ruined by the accumulation of salt to their former fertility. It was a difficult job, due mainly to the problem of removing the remaining water. Having accumulated in the lowlands after having washed the salty highlands, it produced, on evaporation, such a great volume of saltpetre that in some cases—as can be seen in the illustrations—they appear like snow-covered lands.

Distribution

One of the most important consequences of rice-growing authorisation in these areas has been the obtainment of many hundreds of hectares of rice fields in the very short time of three or four years, even in areas such as the province of Huesca, where the lack of adequate water supplies had made useless the lands that were previously fertile dry farming areas.

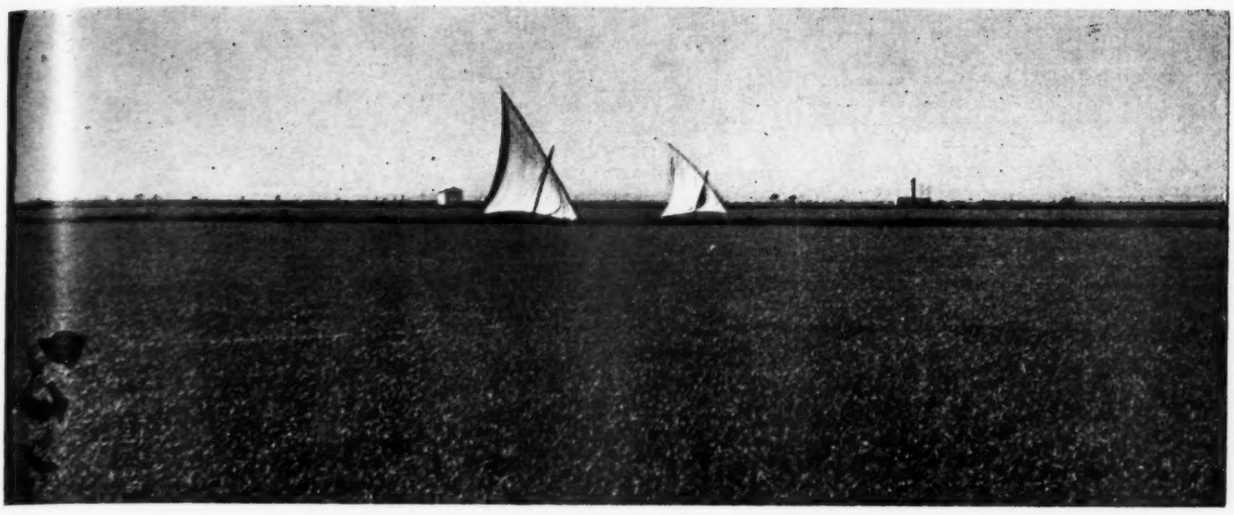
To give an idea of the increase of this crop, let us say that the total area today is approximately 70,000 ha., of which 20,000 ha. have been established since the civil war; these 20,000 ha. are distributed in 13 provinces, of which the most important is Sevilla with some 8,500 ha. in sea marsh lands; next in importance are the provinces of Lerida, Huesca and Zaragoza in the Ebro Basin, with a total of 6,000 ha.

The rice fields of Sevilla are all in marsh lands. In those years in which it has been possible to irrigate with fresh water, with careful cultivation, excellent production of up to 9,000 kg. per ha. has been attained. Since the rice fields are situated along the banks of the Guadalquivir and are irrigated from this river, there have been years in which the strong tides have caused the fresh water and salt water to mix in proportions unfavourable to rice cultivation.

Two types of soil

The two main causes of the extension of cultivation are due to the reclamation of land made useless by inadequate water drainage and the

A close-up view of reclaimed land which is useful for rice growing



Ripe rice and sailing barges near La Albufera, Valencia

utilisation of marsh lands, giving rise to two types of rice at the present time.

On the one hand, there are the crops planted in those lands which, for one reason or another, have a salinity produced by accumulation over many years, and in which the cultivation of rice, because of the great quantity of water it requires, has the remedial effect of intense washing; this, moreover, is bringing about the restoration of some of the best lands whose soil was of excellent quality. In these cases the cultivation is of a temporary nature with a maximum duration of seven years, at the end of which these lands are considered to be recovered completely; the time is sufficient to finish the network of drains and canals and prevent a repetition of the salty conditions.

The second type of salty or marshy soils are of a more permanent nature, for in many cases the water used for irrigating has considerable salt content, so that it is not possible to wash the land completely. All that can be done is to stop the increase in salinity, so that the salt level is lowered, thus making it possible to obtain rice crops which, because of the favourable conditions, should be very profitable. If these soils are not devoted to rice growing, the salt level would increase (by capillary action), preventing the growth of subsequent crops. It is easy to understand that in these lands the authorisations for rice cultivation are permanent, and in Spain are called ' coto arrocero ' (fields limited to rice). These lands will become typical rice areas like Valencia and the Ebro delta, which have been traditional rice-growing areas since before the war.

New rice fields in Lerida. Potassium nitrate has effloresced and gives the appearance of snow

Commercial view

The return to normal wheat production after the years of drought, and especially after the last two excellent wheat crops, has brought about a crisis in rice consumption. Prices have fallen and stocks have accumulated; the natural outcome should be to export, since the internal consumption is not able to absorb this excess of production, *i.e.* in normal circumstances and with sufficient supplies of wheat for normal needs. Export of rice, common in the years of plentiful crops before the war, had been stopped until two years ago. Today the situation explained above has given rise to a need for foreign markets.

The rice excess of some 60,000 to 70,000 metric tons has been sold in other countries—in particular Japan, since this is the only country with the ability to absorb our stocks. Small quantities of first-quality rice have also been exported to England and Germany, but the present decline in world prices seems to indicate drastic measures if a repetition of the crisis suffered by Valencia and the Ebro delta is to be avoided.

Continued on page 414

Spraying Techniques and Machinery in the Sudan Gezira—II*

A. M. TOMS, N.D.A.

(*Spraying Officer, Sudan Gezira Board*)

Mr. Toms completes his series on spraying techniques in the Gezira by making special reference to the entomological problems in order to show how they influence machinery design and type.

THE machinery in use at present is essentially of two types: the machine towed by the tractor and the machine mounted direct on to the tractor. The towed machines have tank capacities of 300 or 500 gal. and the mounted machines have a tank capacity of 150 gal. The width of the spray boom is either 35 or 40 ft., depending upon the operator, but the Gezira Board have standardised all their machines with 35-ft. booms. The merits of the various types will be discussed below, but it is worth noting that, owing to the irrigation cross ridges, which are broken down to a certain extent by bull ploughs before the passage of the spraying machine, the machines bump as they work and have considerable strains put on them, far in excess of their usual work on, say, cornfields. The usual speed of spraying is 5 m.p.h. and this is the fastest speed possible in view of the ground conditions. All the theoretical output calculations discussed below are based on this speed.

Filtration in any spraying machine must be good, but this is particularly so in the Gezira, where the water is pumped direct out of the canals into the machines and very-low-volume spraying is carried out. The water in the canals appears dirty, but in effect it only contains a fine colloidal clay suspension which is not abrasive, is not filterable through normal spraying machinery filters, and does not cause nozzle blockage. It is, however, essential to prevent any particles of vegetative matter from the canals reaching the nozzles, as this will very quickly cause blockages; the suction hose from the pump to the machine must be placed in a filter in the canal. In addition to the normal filters in the machine, fine filters behind every nozzle have proved advantageous.

The nozzles used fall into two types, namely the hollow cone and the fan jet. Both types have their advantages, but there is no difference in their efficiency for jassid control and the choice is largely a personal one. The fan jets used have the advantage of having a detachable filter behind each nozzle and a knurled holding nut, which is easily screwed and unscrewed by hand. There has been no difficulty in having the fan jets placed in line along the boom.

It must be remembered in all these considerations that the labour employed on this spraying is all Sudanese, with a very minimum of supervision by fully-trained technicians, and therefore the ideal spraying machine is the simplest mechanically, yet the strongest and most efficient. Design of the machinery is of the utmost importance in view of the strain placed upon the machines under the conditions in the Gezira. This applies to all types of machinery used.

Spraying-machinery design

Until recent years it was remarkable how many spraying machines were built and how few were actually designed on a drawing board. Even those that saw a drawing board were rarely designed with a view to withstanding all the stresses and strains placed on them and yet employing the greatest economy in metal and weight. This is particularly the case in respect of the spray booms.

Experience in the Gezira has shown that, with spray booms of 35 ft. and over, a rigid boom is much more prone to strains and stresses than a boom with a certain amount of flexibility which is able to absorb the terrific whip that develops on the end of a spray boom. In a total boom width of 35 ft. each side boom is 14 ft., and it is essential that there is some method of preventing all the whip from the

TABLE 2
THEORETICAL OUTPUTS OF SPRAYING MACHINES

Gal. per feddan	*No. of loads per 12-h. filling time (10 min. included)*	*Feddans per 12-h. day*	*Output gain per day, feddans*	*Output gain, %*
150-gal., 35-ft. boom, tractor-mounted machine				
100	50	75	—	—
60	42	105	30	40
30	30	150	45	43
20	23	172	22	15
10	13	195	23	13
5	7.50	225	30	15
2	3.25	240	15	7
0.4	0.68	255	15	6
300-gal., 35-ft. boom, towed machine				
100	39	117	—	—
60	30	150	33	28
30	19	190	40	27
20	14	210	20	11
10	7.50	225	15	7
5	4	240	15	7
2	1.7	255	15	6
0.4	0.35	262	7	3

* Part 1 : World Crops, 7, 306, 1955.

end of each 14 ft. of spray boom being transmitted to the holding back frame. If this is not done, the back frame must be so heavy and strong as to be out of proportion constructionally with the side booms.

There are two methods of overcoming this. One is by using a conventional rigid boom, but its attachment to the back frame at the top is through a shock absorber. The second is by a more flexible boom in which the whip is absorbed by its flexibility and transmitted on to a compression spring on the boom itself, so that nearly all the whip and strain is absorbed on the boom and very little is transmitted on to the back frame. Fig. 2 illustrates such a boom, which has so far completed 13,000 feddans of cotton spraying without any breakages, except for replacement of springs. The breaking of the cross-member of the boom in the centre and the two strengthening ties joining at this break give flexibility within the boom itself and relieves the compression spring at the top of much of its work. The two springs alongside the compression spring are tension springs to allow the boom to recover from the shock.

Fig. 3 illustrates a machine spraying cotton under typical conditions, having just gone over a tagnet. It shows how flexible the booms must be to withstand such a strain.

Fig. 2. Mounting of flexible boom. Because of the way in which it is mounted, very little strain is transmitted to the back frame

Machinery output

The theoretical maximum outputs have been compiled for the two types of machines operated by the Sudan Gezira Board and are given in detail in Table 2.

This theoretical maximum output can never be attained, since time is lost by such items as greasing and refuelling, travelling to and from site of work and base, and moving between cotton numbers. When these items are deducted the practical maximum output figure is obtained, and this is 83% of the theoretical maximum output as calculated in Table 2. This figure of 83% is most important, as it is almost the same for any type of machine and will be only slightly increased when the machine is working 24 hours per day.

Just how accurate this figure is can best be illustrated by the performance of one 150-gal. machine in October 1953, when, in 12 full working days of 14 hours each, it completed 2,664 feddans, an average of 222 feddans per day. This is its actual computed practical maximum average daily output, *i.e.* 83% of the theoretical maximum output. During the period this machine had no breakdowns and was working on one block, where the work for it was planned extremely well. Throughout a season there are breakdowns and time lost travelling from one block to another, etc. Table 3 gives the average outputs of the two types of machines over the two seasons 1953 and 1954.

This table shows that the 150-gal. tractor-mounted machines are as much as 10% more efficient than the 300-gal. towed machines under Gezira conditions. This is chiefly due to fewer breakdowns and greater manoeuvrability of the smaller machine, again stressing the point that under these conditions the mechanically simplest machine has proved the most efficient. The contractors have also found this to be so and using 500-gal. towed machines with 40-ft. spray booms and spraying at 16 gal. per feddan find that they obtain approximately 70% of the maximum practical output under field conditions. This is comparable to the above figures, particularly in view of the fact that they have more skilled supervision.

TABLE 3

ACTUAL AVERAGE OUTPUTS FOR THE SEASONS 1953 AND 1954*

Year	*150-gal. machine*			*300-gal. machine*		
	Output, feddans	*Practical maximum output*	*Efficiency, %*	*Output, feddans*	*Practical maximum output*	*Efficiency, %*
1953	Spraying at 15 gal. per feddan			Spraying at 20 gal. per feddan		
	146	184	79	128	203	63
1954	Spraying at 5 gal. per feddan			Spraying at 10 gal. per feddan		
	170	234	73	151	233	65

*In 1953, 14 hours per day were worked; in 1954, 15 hours per day.

Future experimental work with land machines

It has been considered, and rightly so, that the lower the volume sprayed per feddan then the higher the potential output per machine. This can only be carried so far in that the Law of Diminishing Returns comes into operation, as all other factors except the volume are constant. Also the lower the volume the more delays there are likely to be with blocked nozzles on the conventional land machines. The Law of Diminishing Returns will, of course, come into operation at a higher volume the larger the tank capacity of the machine.

With both 150-gal. and 300-gal. machines with 35-ft. spray booms the most economical volume appears to be 5 gal. per feddan, but with a 500-gal. capacity tank and 40-ft. spray booms

16 gal. per feddan is the preferable volume. It is, however, possible that if the addition of water to the chemical can be eliminated there would be a considerable saving in time lost due to blocked nozzles. A machine for applying undiluted chemical has been designed by R. J. Courshee, of the National Institute of Agricultural Engineering, and will be tested in 1955.

As with aircraft spraying, this machine will apply undiluted chemical in the form of a straight oil without emulsifiers and, as this is a cheaper formulation, there will be a considerable saving from this point of view. In respect of increased output, applying the undiluted concentrated chemical at 0.4 gal. per feddan means that the theoretical output can be raised 13% and 9% respectively with the 150- and 300-gal. machines from 5 gal. per feddan. How far these theoretical calculations will be borne out in practice remains to be seen, but it does appear at first sight that they are high in that the machine is considerably more complicated than the conventional machines now in use. There is the possibility that this machine will apply the insecticide more efficiently, in which case even without any increase in output it will be a more practically efficient machine. As will be seen from Table 2, the maximum theoretical output of this machine with a 150-gal. tank capacity is 255 feddans per 12-hour day and a maximum practical output of 211 feddans per 12-hour day. It will be interesting to see how close such a machine will come to this figure.

Discussion

Unfortunately in any discussion regarding spraying machinery and techniques in the Sudan Gezira mention must be made of the entomological problems in order to illustrate how they influence machinery design and type. This is in no way intended to be an entomological review of the insect pests on cotton, but they must be understood and appreciated before decisions concerning machinery type can be made. Similarly, the mode of action of the insecticide being used must be understood. This means that the insects, the chemicals to kill them and the machinery to apply the chemicals should all be studied together and research work carefully co-ordinated between the three. It is, no doubt, due to the fact that such co-ordination does exist in the Sudan that such rapid strides have been made in the Gezira during the past nine years, so that today it leads the world in some of its spraying application techniques. This is an acknowledged fact and it is a tribute to the spraying contractors operating in the Gezira, to the entomological research workers of the Sudan Ministry of Agriculture and to the management of the Sudan Gezira Board, who, all together, form a closely co-ordinated spraying investigation and development team.

Fig. 3. Dorman sprayer in action. Note flexibility: right-hand boom elevated (Sudan, 1953)

When spraying commenced in the Gezira the cotton jassid (*Empoasca libyca* de Berg) was considered to be the major pest and the only one that needed insecticidal treatment. Originally it was considered necessary thoroughly to cover the whole of the cotton plant with spray, using downpipes, at the rate of 1 lb. of DDT in 100 gal. of water per feddan. It was gradually demonstrated that this volume of water was excessive, that the downpipes were unnecessary with low-volume techniques and that aircraft were suitable for the spraying. In the southern part of the Gezira thrips (*Hercothrips* spp.) can be a problem. They can be controlled by the same techniques as jassid. The next step was to find that 1 lb. of DDT is excessive for jassid control by low-volume spraying; ¾ lb. has already proved effective and further research is still proceeding along these lines.

In the past four years, however, it would appear that the insect complex is altering and, possibly due to large-scale DDT spraying plus the increased use of nitrogenous fertilisers, whitefly (*Bemisiq tabaci* Genn.) and American bollworm (*Heliothis armigara* Ham.) have become pests of major importance. Their control is now under study and whatever measures for their control are adopted an alteration in spraying technique is highly probable. It is possible that for whitefly control aircraft spraying will have to be abandoned and a reversion to high-volume spraying will take place. If this occurred, then no doubt the smaller tractor-mounted machines would be at a disadvantage compared with the larger-capacity towed machines. Also, for accurate application with downpipes the present techniques are inadequate and machinery modifications must take place in the future.

It is again possible that the use of highly toxic organophosphorus compounds may be necessary to control these pests. In this case special precautions would have to be taken to protect the native workers from these poisonous sprays and close co-operation with the machinery manufacturers would be essential. It is to be hoped that the chemists will continue their good work in producing sprays, highly insecticidal but with low mammalian toxicity, which can replace the present highly toxic ones.

It has only been during the last two or three years that any basic research has been carried out on nozzle performance, droplet patterns and opti-

mum droplet sizes, particularly in relation to the quantity of liquid being sprayed and the lethal dose required. The National Institute of Agricultural Engineering now have the performance and droplet pattern of most commercial nozzles and it is most disturbing to note how few can be said to give an even droplet pattern and in how many this fault is one of manufacturer. Just how much a slightly uneven droplet pattern will interfere with efficient weed or insect control at fairly high concentrations of chemical and an application rate of 10 gal. per acre and over is probably very slight. With efficient nozzle performance just how much chemical concentrations could be reduced and spraying operations cheapened is a matter for conjecture. But in the Gezira the application rate is below 10 gal. per feddan and we are endeavouring to reduce the chemical to a critical low concentration. Under these circumstances nozzle performance is of great importance and basic research is of the utmost value.

In conclusion, just one word of warning to research workers, particularly in respect to spraying machinery. Bench tests, small-scale trials and theoretical calculations can be seriously upset by field conditions and, although this research is absolutely essential, definite conclusions should not be formed or even inferred until large-scale field trials have been carried out under all conditions. Many ideas have been publicly expounded only to fall down during large-scale tests, but in the meantime much harm has been done by creating a wrong impression and sometimes considerable sums of money uselessly spent.

Summary

1. A brief outline of the history of spraying in the Sudan Gezira has been given.

2. The technique of aircraft spraying is reviewed, in which the aeroplane is used as an air-borne ultra-low-volume land machine.

3. The possibilities of non-conventional aerial spraying, *i.e.* drift spraying, are discussed, with its bearings on spraying costs.

4. Land spraying machinery and its design are described in some detail, with tables showing the comparative efficiency of output of various types.

5. The advantages and disadvantages of ultra-low-volume spraying by land machine are discussed, with spraying costs again as the prime consideration.

6. Reasons are given why spraying machinery and spraying techniques require the attention of a fully co-ordinated team of research workers connected with any one particular crop protection problem.

Acknowledgments

The writer wishes to acknowledge the kind assistance given in the preparation of this article by the Government Entomologist, Sudan Government; the Agricultural Manager, Sudan Gezira Board; the Managing Director, Pest Control (Sudan) Ltd.; the management of Aerial Spraying Contractors Ltd.; and Plant Protection Ltd. The writer is grateful to the management of the Sudan Gezira Board for permission to publish this article.

Photos: Fig. 2, Dorman Sprayer Products; Fig. 3 Plant Protection Ltd.

Plant-growth Substances

The Third International Conference on Plant-Growth Substances was held at Wye College, London University, from 17 to 22 July, 1955. The organiser was Prof. R. L. Wain, Head of the Department of Chemistry at the College. The scope of the conference was somewhat wider than the previous one held at Lund, Sweden, in 1953 and was concerned with the broad chemical and biochemical aspects of the subject and little attention was therefore given to what may be called the biology of plant-growth substances.

The relationships between chemical structure and biological activity claimed a major fraction of the formal programme. The respective claims of the two rival theories of auxin action, one based on a direct chemical combination of specific active points in the molecule with receptor sites in the protoplasm and the other based on a physico-chemical action dependent on stereo-chemical relationships, were argued against a background of new synthetic compounds. One major point in this issue was the announcement that a class of new compounds, not possessing the unsaturated ring, once thought to be an essential for activity, were active as auxins. They are the carboxymethyl - *N* : *N* - dialkyl - dithiocarbamates. The new field of anti-auxins came in for its full share of attention.

The study of natural growth substances and their metabolism in the plant has obviously received a new and revivifying stimulus from the application of paper partition chromatography. The development of a whole range of new selective growth regulators has undoubtedly been made possible by the discovery of the differences which exist between plant species in regard to the ease with which they metabolise synthetic organic chemicals and convert them to active growth substances. Several papers dealt with this aspect of the subject.

Announcements were also made of the identification of some of the natural growth substances that stimulate cell division and which are present in the nutritive tissues (endosperm) of seeds. One such substance is 1:3-diphenylurea. Others belong to the group of leucoanthocyanins.

Considerable attention was also paid to the ultimate biochemical and physiological mechanisms of growth substance action and a number of new theories were advanced.

The formal papers given at the conference will be published in a special volume, which should appear before the end of the year.

L. J. Audus

Italy Reclaims Land from Adriatic

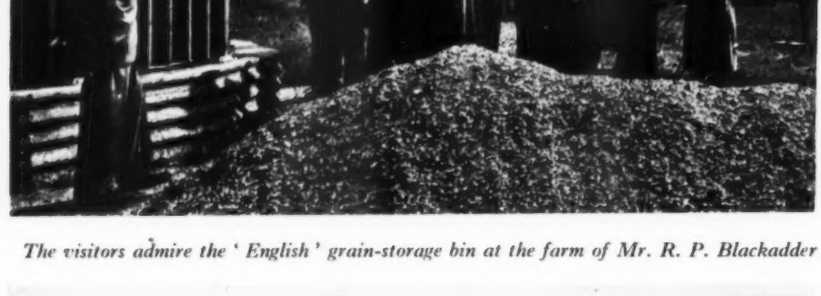
Italy is reclaiming land from the Adriatic Sea, and where fish swam last summer rice will be growing this summer.

The work is being done at the delta of the Po. The land reclaimed from the sea was under the famed lagoons of the Comacchio. The lagoons were drained and desalted and experts forecast they will be extremely fertile. So far three areas have been drained and desalted. Rice was planted in June. The experts forecast that it will take about 20 years of cultivation before the reclaimed areas reach their prime.

Other large areas are waiting to be reclaimed. One area is estimated at 80,000 acres and several other regions in the Po Delta are about 15,000 acres in extent.

Hands Across

The visitors admire the ' English ' grain-storage bin at the farm of Mr. R. P. Blackadder



A fine first stand of cereal on the reclaimed land at Crux Easton

The Farm Manager (Mr. R. Deacon) at Crux Easton explains some details of the reclamation operation

In these days, when the efficient use of land in Great Britain is becoming more and more important, increasing interest attaches to the reclamation for agricultural production of small and often unconsidered areas of land which have for one cause or another been allowed to run to waste or which have not been cultivated for centuries.

This was the motive that prompted Mr. W. Leonard Hill, Chairman of Leonard Hill Limited, the publishers of WORLD CROPS, to undertake the reclamation for agricultural use of several portions of his 800-acre estate at Crux Easton in North Hampshire. Thus, when Mr. Hill learned that a party of Australian farmers were touring Britain (as part of a tour which includes the Continent, the U.S.A. and Canada) under the auspices of the Australian Primary Producers' Union —a body equivalent to the National Farmers' Union—he extended an invitation to them to visit his estate and to see the results of the reclamation work undertaken there.

The group arrived at Crux Easton towards lunchtime on 22 July, and was greeted by Mr. and Mrs. Hill and entertained with aperitifs and a splendid luncheon set in a picturesque thatched barn.

Of the 800-acre estate, 250 acres are woodland, or were, as 60 acres have been reclaimed recently; 500 acres are let to farming tenants. The land varies from 550 ft. above sea level to nearly 800 ft. and is mainly chalk land with a deep clay cap at the higher levels.

The 60 reclaimed acres were originally heavily wooded and the timber included oak, beech, maple, hazel and elder. Work was started in the winter of 1953–54, when the heavy timber was felled and removed by contract; the larger tops were then cut and with the underwood pushed out with an Allis-Chalmers tractor on which a large ' comb ' was substituted for the 'dozer blade. The large stump-roots were blasted, then the whole was pushed up into windrows and burnt.

A heavy cutter-bar was then dragged through at a depth of approximately 6 in. The larger unburnt stumps and roots were raked off and burnt and the land was then disked several times.

the Ocean

At the date of the visit, 22 July, 1955 (one year after the contractor had finished), a good hay crop had been taken off and baled; this was satisfactory, even though it should be explained that one of the fields was intended for grazing in the first year. The cereal crops were in good condition. The 60 acres have been divided and all divisions supplied with water—the fencing posts were cut, pointed, barked and creosoted on the estate. The group were impressed with the wonderful recovery made by the land and by the planning and fore-thought that went into the operat on.

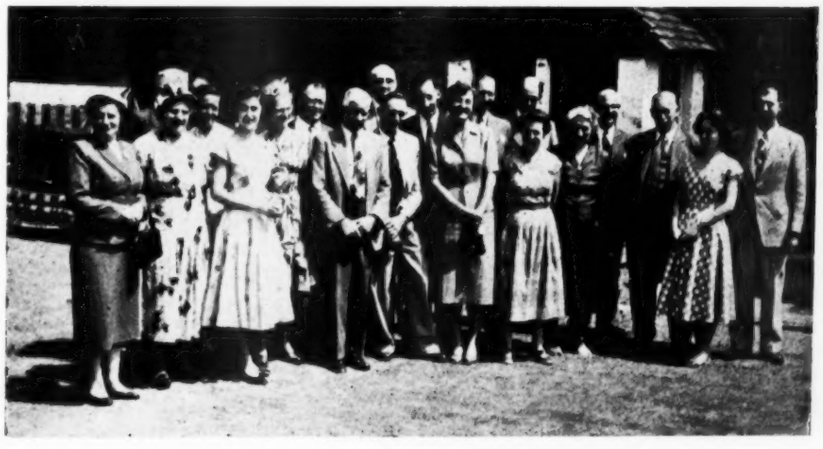
During the afternoon the party moved on to Norton Manor Farm, Sutton Scotney. This farm is tenanted by Mr. R. P. Blackadder, who maintains a dairy herd of Ayrshire cows. The farm itself is a typical light-land Hampshire farm running from river level to chalk uplands. The dairy herd is grazed on the river-level lands and a beef-breeding herd of Hereford cross Angus cows are run in conjunction with a grass-seed production plan in order to maintain the fertility of the uplands.

Barley and wheat are the main grain crops and these are grown and handled with the most modern methods of large-scale grain production used at the present time in Britain.

Before returning to London the party were entertained at tea by Mr. and Mrs. Blackadder. In a large marquee, pleasantly situated in the gardens of Cranbourne Grange, Mr. W. Jacob, leader of the Australian party, expressed admiration for the tenacity and foresight shown by both Mr. Hill and Mr. Blackadder in their endeavours to make efficient use of their properties. He said that it was due to men like these that British farming had an immense lead over that of other countries and that if more were to follow their lead agricultural production in Britain would derive even further great benefits.

Speaking on behalf of the group, he expressed unbounded thanks to both hosts for the day and assured Mr. Hill and Mr. Blackadder that the group would return home with many memories of their excursion in Hampshire.

Reading from left to right: Mr. W. Jacob (leader of the A.P.P.U. party), Mrs. Hill Mrs. Jacob and Mr. W. Leonard Hill



Some of the group on the lawn at Crux Easton

Some of the Australian farmers with Mr. W. Leonard Hill

A harvest picture from the province of Skane, South Sweden. This area is sometimes called 'Sweden's Granary'

Swedish Agriculture Today

M. GORDON

SWEDEN now claims to be self-supporting as far as her food requirements are concerned. This is no mean achievement for a country which has extensive forests and a soil that is exceedingly varied in character.

Extent of holdings

This has not been achieved by collectivised farming, nor is it due to large-scale farming. Of the 400,000 farms, rather more than a quarter have less than five acres, a further quarter do not exceed 12 acres, and another quarter are between 12 and 25 acres. Less than one-quarter are in excess of 25 acres. Thus some three-quarters of Sweden's agricultural land is farmed fragmentarily. Only 0.6%, in fact, of farms are of more than 250 acres, and the country might accurately be described as one of smallholdings.

The average for the whole country is estimated at 22 acres, a situation which, it would seem, discourages mechanisation. As will be seen, this has not proved to be the case, but such a close division of the land does dominate the type of crops produced.

Although there has been a marked drift from the land in Sweden, immense increases in output have been achieved. This is largely due to increased mechanisation and better production methods.

This is also vitally affected by natural conditions, which vary extensively throughout the country.

Crops

In Skane large quantities of wheat, sugar-beet, two-rowed barley and oil-seeds predominate. Skane also produces most of the seed for the growing of Sweden's forage crops and vegetables and provides large quantities of vegetables also. In central Sweden the emphasis is on two- or three-year leys, clover, grass and an extensive cultivation of oats. Winter grain is also grown, usually for one year in a seven-year rotation. In the plains in this region winter and spring grains in recent years have given place to oil crops. Along the east coast oats are largely replaced by barley or by a mixture of barley and oats.

The plains of Ostergotland being fertile, spring wheat and certain oil crops predominate, whereas on the islands of Oland and Gotland clover leys and barley have pride of place. The cropping system of south and central Sweden prevails for some distance north of the great central Swedish lakes and as far as a line somewhat north of the Dal River.

Beyond this leys take up over 50% of the land under cultivation. In the northernmost province leys occupy 80% of the cultivated land. Winter grain decreases, disappearing altogether the further north the visitor travels. The root-crop acreage is trifling and, apart from grasslands, it is spring grains which play a more noticeable part, six-rowed barley being the most prevalent.

Potatoes are grown throughout the country and in some regions, such as the province of Blekinge, this cultivation sets its stamp on agriculture. Oil

rops, too, are found in various parts of the country.

The percentages of bread grain and potatoes have remained constant since 1870. The former averages 11–12% of agricultural production and the latter 5–6%. The most pronounced change has taken place in fodder roots, sugar-beet and root crops. These, which only accounted for 1% of production in 1870, now account for 10%.

Barley and oats, which are cultivated both separately and as mixed grain, together occupy a much larger acreage than the bread grains, wheat and rye. Although some winter barley has been grown in southernmost Sweden in the last few years, it is generally spring sown. Barley, a fairly high percentage of which is used in the manufacture of malt beverages and some to make bread, is for the most part used for feed. Oats, used mainly for horse feed, have dwindled and still do so, due to the fact that the number of horses continues to decline.

Pulses, such as peas, beans and vetches, have declined to such a level that they occupied only 60,000 acres in 1951. Pride of place was taken by ley for hay with over 3 million acres, oats taking second place with just over 1¼ million acres and spring and winter wheat coming third with slightly over 800,000 acres.

There have been considerable fluctuations in the acreage devoted to oil crops, reaching an all-time record of 475,000 acres in 1951 and falling to 370,000 acres in 1952. Vegetables claiming the most land are carrots, onions, white and red cabbage and brown peas, which are unusually popular in Sweden.

Measurement of crops

Crop increases are estimated in units, which vary according to the item under consideration. For instance, a crop unit of wheat, rye, barley and peas is 1.2 kg. or 2.64 lb. and a crop unit of oats is 1.1 kg. or 2.42 lb. A crop unit of potatoes and sugar-beets is 10 kg. or 22 lb. Although the yield per acre inevitably varies throughout the country, the average for the whole is estimated at 1,000 crop units per acre.

In 1939 the crop units were officially estimated at 10,000 millions, as against only some 6,000 million units in 1900. Thus within 39 years, and thanks in part to the impetus of the first world war, production rose by 4,000 million units. 1939, however, was an exceptional year and cannot be accepted as average. The picture is seen more clearly in the years 1930–38, when production was about 9 milliard (1 milliard is equivalent to 1,000 millions) units per annum. Thus in 30 years Sweden increased her crop output by one-half of the 1900 figures. As we have seen, there were crop changes in that period, but the overall achievement can only be regarded as highly satisfactory.

Livestock

Livestock development is, of course, as much a matter of quality as of quantity. Naturally, because of mechanisation, the number of horses has declined. The highest number was 728,000 in 1920, and the total in 1952 had fallen to 386,000.

Two factors have operated in reducing the cattle population from the peak of about 3 millions in the years 1936–39 to rather more than 2½ millions in 1952. One, of course, was the war itself. Equally harmful, however, were the crop failures of 1940 and 1941, which necessitated fairly heavy slaughter. The number rose again from 1943 to 1946, but fell again, principally because the inferior animals were killed off.

In 1927 the closely related breeds, Swedish Ayrshire and Swedish Red and White cattle, were merged into one breed called Swedish Red and White cattle, and the two North Swedish breeds were merged into one called Polled Swedish cattle. These are dairy cattle and along with the Swedish Friesians make up the country's 1½ million milking cows.

The Friesian breed accounts for some 25% of all registered cattle and is found mainly in southern and central Sweden. It is a descendant of Friesians imported from Holland and north-western Germany. The Swedish Red and White cattle are distributed throughout the region between Skane and central Norrland and are dominant in central Sweden. The Polled Red cattle are encountered mainly in Dalarna and the Polled Whites are located almost exclusively in Norrland.

The Friesians give the highest milk yield with 9,980 lb. of milk, the butterfat content amounting to 3.71% or 370 lb. Red and White give 8,663 lb. of milk, the butterfat percentage being 4.01% or 348 lb. The Polled White and Red provide 6,500 lb. of milk with a butterfat percentage of 4.23 or 275 lb.

The average live weight of the Friesians is 1,375 lb., the Red and White average 1,211 lb., the Polled Reds 1,014 lb. and the Polled Whites 904 lb.

In 1910–14, the milk yield from tested cows averaged 6,393 lb. with 3.4% butterfat. In 1950–51 the yield had risen to an average of 8,716 lb. with a butterfat content of 3.96%. The yield from non-tested cows has risen at about the same rate, and the measure of the progress made is gathered from the fact that the average

A cow of the Swedish Friesian (Lowland) breed, one of the dominating breeds in Sweden and the one that gives the highest milk-production figures

increase from 1939–51 is approximately 1,080 lb. per head.

According to Hugo Osvald of the Swedish Institute of Agriculture, the improvement is due very largely to successful breeding, which has been governed by the yield tests. Feeding, too, has been greatly improved and much of the progress owes to a more competent knowledge of what the animals need in the form of mineral substances and vitamins. Other factors contributing to the improvement are the better care of pastures, more careful haymaking, the earlier harvesting of leys and a wider use of silage.

Pigs

The rise in the pig population has been such that Sweden, which met part of her pork requirements from imports in 1910, today exports fairly large quantities of pork. The numbers have risen from rather less than a million 45 years ago to about 1,343,000 in 1951. The two breeds of pigs are the English Large White and the Landrace, a native breed. The breeding of both has been directed towards a fast-growing bacon pig. This development has resulted in Sweden no longer being able to meet her own pork requirements.

Sheep have never played a conspicuous part in Swedish agriculture. Since the war the number has dwindled steadily, and the 1951 figure was only slightly more than a quarter of a million. Goat raising, which is limited to Norrland, is of no significance, the number of animals amounting to no more than 15,000.

Poultry

The most popular breed of poultry is the White Leghorn, followed by the Rhode Island Red. In the inter-war years an improvement in quality and numbers took place rapidly and, although there was a decline in quantity during the war years, the pre-war figure was restored by 1947. The present figure is in the region of 12 million birds, a number which allows the Swedes to export a considerable egg surplus.

Subsoil drainage

That Sweden has achieved self-sufficiency in her agriculture and is producing enough to meet her own needs has been accomplished in a variety of ways. Naturally the improvement in crop and livestock yields has played a prominent part. Careful breeding, the cultivation of more productive crops and a more economical use of the land have played their part. An important requirement for the increase was improved subsoil drainage. This has had Government support, and today more than a quarter of agricultural land has the benefit of this type of drainage. In some regions the percentage is in excess of 50, although the 5-acre farms still lag considerably in this direction.

In 1953 Swedish farmers spent Kr. 330 million (Kr. 14.4 = £1 sterling) on farm machinery, out of which one-half related to tractors and almost one-fifth to harvest combines. Farmers on smaller farms often own a combine jointly

Of greater importance is the remarkable increase in the use of lime and fertilisers. In 1931 nitrogen was being applied to land at the rate of 5.75 lb. per acre. By 1951 the amount had risen to 13.7 lb. per acre. Comparable figures for phosphorus are 5.21 lb. and 10.3 lb., and for potassium 5.78 lb. and 10.4 lb. It has been estimated that this increase in the use of fertilisers accounts for at least a 20% rise in the total crop.

The care of manure has also played an important part in increasing production. Livestock in Sweden are large in number in relation to the acreage, and cattle manure accounts for a high percentage of plant nutrients. During the last 30 years considerable capital has been invested in providing concrete manure pits. In this way nutrients hitherto lost are being preserved to the benefit of the soil and the crops.

Plant breeding

Plant breeding has played a notable part in raising output. A hardy type of cereal is needed in Sweden and that this has been provided is due to the services of the Swedish Seed Association and the Weibullsholm Plant Breeding Institute. Foreign plants, by selection, were improved and the better and hardier varieties were cross-bred with types native to Sweden. These displayed the necessary resistance to disease, particularly to stripe and yellow rust, and gave a yield increase ranging from 15–50%, depending on the region in which the wheat is grown. Advances, too, though of a less spectacular nature, have been made in breeding rye, oats and barley, yield increases ranging from 15–25%.

The need in ley and pasture management to adapt the seed to climate has been very largely met. This has been made possible by the development of domestic seed. The quality of hay from the leys is now considerably improved, particularly since earlier harvesting has become the general practice.

Of immense importance in improving cattle standards has been the extensive development of pastures made possible by the work of the Swedish Grassland Society. Before

this took place cattle in Sweden grazed almost entirely on forest land and on inferior natural grassland. In fact, many herds were fed indoors right throughout the summer. The development of pasturage has put an end to this and, whereas cultivated pastures consisted at first of improved forest and park land, today pasturage is largely provided on arable land.

Labour drift

The immense increases in output in every sphere of Swedish agriculture have been achieved even though there has been a marked drift from the land. In the first half of this century the farm population in Sweden has fallen by almost 1 million. This, in a country of some 7 million people, is an astounding figure. It means, in fact, that an agricultural population which accounted for 60% of Sweden's people in 1900 has dwindled to only 25% today. Between 30 and 40 thousand people leave the country each year, and there is nothing to suggest that the number is decreasing. The decline is most marked among the younger and most productive age groups and amongst women. The 20–40 age group, the most productive and vigorous, accounts for only 29.2% of the agricultural population. In the towns the same age group represents 36% of the working population.

There is also a serious disproportion between the sexes. For each hundred unmarried men between 20 and 40 years of age there are only 42 women. Since 1938 there has been a 15% decline in manpower and experts forecast that this will have reached 31% by 1960.

That this wholesale desertion of the land should have an adverse effect on agriculture is certainly not what has happened. In the last 50 years production has been doubled. This means that the 2 million people in agriculture are producing twice as much as did 3 million people 50 years ago. And this in a country of smallholders, in which 203,000 farms, covering a third of the cultivated land area, are between 5 and 25 acres and are regarded as unprofitable.

Mechanisation

The answer to the flight from the land has been found, of course, in mechanisation. And so rapid and extensive has this become that it is described as a revolution. In 1949, 11,173 tractors were bought. Such a large number was regarded by the manufacturers as the peak and a decline in demand was expected. These expectations were so far falsified that in 1950 the tractors bought numbered 13,800; 2,627 more than in the previous year. In 1945, Sweden boasted 20,000 tractors. Seven years later the figure had leapt to 60,000. Between 1929 and 1949 Swedish farmers spent 389,800,000 kronor on new tractors. But the significance of this figure is only realised when it is known that half that sum was spent in the last two years.

The tractor is, as everyone now realises, the keystone of modern mechanical farming. On it depends the use of ploughs, harrows and cultivators, not to mention a large number of other agricultural implements. It provides power, makes for speed and is invaluable in transporting materials and equipment. It is chiefly this which has made it possible for the Swedish farmer to continue to work satisfactorily with a constantly declining labour force. Indeed, the choice has been that of mechanisation or closing down.

Yet the change has been profitable. Not only is labour scarce, but it is also the most expensive factor in farming. The investment in machinery has shown a net saving in man hours and consequently in the costs of production. An acre of land farmed by hand requires 240 hours per acre each year. The machine cuts this to only 82 hours per acre. Compared with 1938, the decrease in the annual number of hours worked is today equivalent to a potential saving in wages of 340 million kronor. A further 80 million kronor a year is being saved in fodder due to the reduced number of horses. As the annual investment in machines and the costs of running them amounts to 170 million kronor above the 1938 figure, the annual net gain is 250 million kronor.

The small farmer faces a difficulty when it comes to purchasing machines such as harvesters and binders. Their limited use makes their cost prohibitive and uneconomical. But farmers' cooperatives are buying these machines and lending them out from central stations when required. The Government, too, is employing cheap loans and free expert advice to try and persuade the small farms to merge themselves into larger units.

Practically the whole of Sweden's farmers have the benefit of electricity. Thus the smallest and remotest farmsteads have available cheap light and power. On many farms electrically-driven machines dry the grain, cut chaff and silage, work elevators and pump water. Many of the womenfolk have the advantages of refrigerators, electric washers and cookers and dish washers.

Sweden, by an extensive employment of the machine, is making excellent use of her agricultural land. Everyone acknowledges that there is still ample room for improvement. But no one doubts that the improvements will be made and that Swedish agriculture will become still more productive, more easy and more profitable.

Photos: The Swedish-International Press Bureau.

Technical News

Food Manufacture for October contains articles on 'Better Food for India's Millions,' by V. Balu; 'The International Bakers' and Confectioners' Exhibition'; 'Texture in Fruit and Vegetables,' by F. A. Isherwood, PH.D., M.A., B.SC.; and 'Caviare for World Markets.'

The October issue of *Dairy Engineering* features transport in the dairy industry, and includes articles on 'The Choice of Vehicles for the Perfect Delivery Service'; 'Milk Distribution in New Zealand,' by T. P. J. Twomey; and 'Vehicles for the Transport of Milk in Bulk.'

Manufacturing Chemist for October includes 'Improving Yields in Antibiotics Manufacture,' by Dr. P. B. Dickenson; and a progress report on Fertilisers and Plant Nutrients.

The contents of *Fibres (Natural & Synthetic)* for October include 'Softening Hard Cuttings of Jute with Diammonium Hydrogen Phosphate' by P. K. Saha and S. K. Banerjee; and 'Improving Natural Fibres' by Lawrence C. Leatherland.

Among the articles appearing in the October issue of *Chemical & Process Engineering* is 'Production of Electricity from Salt and Fresh Water without Fuel,' by R. E. Pattle, M.A., B.SC.

Developments in Poland

The Plant Cultivation and Acclimatisation Institute in Poland has announced that it has produced a new variety of oats. LP-214, as it is called, ripens late and has a very high yield, averaging about 30 quintals per hectare (23 cwt. per acre). Experimental cultivation in various parts of the country, both by the Institute's stations and by amateur plant breeders, confirms these figures and indicates that the new variety has a good resistance to many kinds of pest.

Polish mushroom spawn

World mushroom production is on the increase and the 1953 output is estimated at about 100,000 tons.

The increase may be attributed in part to the improved quality of mushroom spawn now becoming available. It was customary until recently for growers to buy bricks of spawn which were then multiplied in their own mushroom houses, but many growers are now turning over to pure cultures, which are found more reliable.

The Polish Mushroom Spawn Farm was founded by T. Bukowski, author of several scientific works on mushroom breeding. The farm consists of three departments. In the breeding section mushrooms are selected on the basis of experiments designed to establish speed at which the mycelium permeates the substratum, degree of fertility and resistance to disease.

In the laboratory mycelium from mushrooms selected in the breeding department are collected in conditions of absolute asepsis and allowed to germinate in test tubes on a substratum of agar. Germination takes from six to eight days and the spawn is fully developed within a fortnight. The culture thus obtained is put into bottles filled with a sterile substratum. When it has permeated this substratum it constitutes the final culture, which is ready for breeding.

It is then passed to the production section, where it is placed on a substratum of specially prepared horse manure and peat. This is put into special containers and sterilised to destroy all microflora before the pure culture is added to it. The containers are kept in air-conditioned premises with uniform temperature and humidity, and efficient ventilation for six weeks, when the substratum is fully permeated with the spawn. The contents of the containers are then turned out as cylinders of mushroom spawn 10 cm. in diameter and 20 cm. high. Their dry weight is 300 g. One cylinder is sufficient for 5 sq. m. of mushroom bed.

Several varieties of Polish mushroom spawn are available from the Rolimpex Agency, Warsaw. The following are the regular products, although it is also possible to have cultures made to special order:

TB-11: large white mushroom, short stipe, fleshy pileus.

TB-17: medium mushroom, chalk white, very fertile, moderately high stipe.

TB-7: small white mushroom; the pileus is suitable for preserving.

TB-18: large cream mushroom; grows in hot manure.

TB-21: medium-sized mushroom, cream colour, high disease resistance.

New Appointment

Dr. A. Neuberger, F.R.S., is resigning from the chairmanship of the Editorial Board of the *Biochemical Journal* on 1 October, 1955. The Committee of the Biochemical Society has appointed Dr. A. G. Ogston, F.R.S., as his successor. The Editorial Office of the Journal was transferred from the National Institute of Medical Research at Mill Hill to the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1, on 1 September. Communications should now be addressed to F. Clark, ESQ., M.A., B.SC., Secretary to the Editorial Board, *Biochemical Journal*, at the Lister Institute.

The Increase of Rice Cultivation in Spain

Continued from page 403

Apart from the commercial methods that Spain is employing to speed up export of rice crops by direct selling or compensations in foreign markets, the most important step already being undertaken—in accordance with agreements with other producing countries—is the reduction of rice-producing areas; this is naturally in the areas that are of a temporary nature. With this in mind, and seeing that the temporary authorisations are running out, it is possible to calculate that within seven years 10,000 ha. of rice fields will be occupied by other crops. So it is hoped that the temporary crisis will disappear from the older-established rice-growing areas.

This article was translated from the original Spanish by R. Lawrence.

Photos: C. R. Freemantle; J. Calafell, Tarrega; and Direccion Gral. de Agricultura.

Technical Developments in Crankcase Lubricants for Tractors—I

Continued from page 400

only result in oil deposits, bringing the tractor out of service for repair much sooner than is otherwise necessary. There is, however, an exception to this rule in the case of the vaporising oil engine, and this will be discussed more fully in a later part of the paper.

Although the use of additives permits longer oil change periods to be practised, if this too were carried to an extreme there would be no advantage in engine life, parts renewal, etc. This is because additives are expendable; a certain quantity of additive peptises so much combustion soot, etc., and no more. Experience shows that oil drained with the additive not completely expended results in even longer engine life.

Pan-American Agricultural Science Congress

The Pan - American Agricultural Science Congress, held in Bogotá, Colombia, on 20 June, was attended by more than 180 delegates from Brazil, Argentina, Mexico, Peru, Costa Rica, Puerto Rico, Cuba, Venezuela, Salvador, Ecuador, Bolivia, Guatemala, Nicaragua, Chile, the United Nations Food and Agriculture Organisation, the Rockefeller Foundation, and U.S. and Colombian universities and scientific institutions.

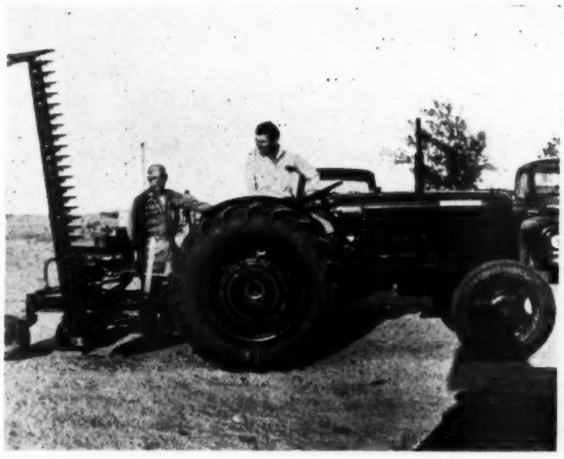
The main purpose of the Congress was to study the scientific and practical methods for increasing agricultural production in American countries.

British Tractors Power American Tools on Pacific Coast

Owing to the scanty rainfall on the Pacific coast of the North American continent, a specialised type of farming has been developed there in which irrigation plays an important part. The growing of crops is generally based upon a system of row-cropping, which provides channels through which the irrigation water flows.

It follows that, in these rich farming areas that lie behind the coastal zones—those of the Frazer and Okanagan Valleys of British Columbia, the mixed-farming areas of Washington and Oregon and the fertile valleys of the Sacramento and San Joaquin and the Imperial Valley in California—farming practice varies considerably from the methods adopted in Europe. Furthermore, tools and implements used in these areas are largely designed and built in the Pacific West to meet the particular requirements of these regions.

When, towards the end of 1953, it was decided to establish a David Brown Company on the Pacific coast it was found necessary to arrange for supplies of locally manufactured implements to be made available in a form suitable for use with their tractors. For instance, the 14-in. and 16-in. mouldboard two- and three-furrow ploughs are widely used on the West Coast and, in addition, a large number of 18-in. single-furrow slow-turning mouldboard ploughs are used in British Columbia and the North-West Territories.



W. W. Nicholson (left), *Sales Manager of the David Brown U.S.A. Pacific Branch, and W. Webb testing the 7-ft. Lundell semi-trailer hydraulic mower*

In the cotton-growing areas of California equipment for dealing with the alfalfa rotation crop, such as mowers and side-delivery rakes, had to be provided and arrangements were made with the Gate City Steel, of Boise, Idaho, to supply 7-ft. side-delivery rakes, and at the same time negotiations were in progress with Lundell Manufacturing Company to provide a 7-ft., semi-trailer, hydraulically operated mower. Only in certain areas of British Columbia is anything smaller than a 6-ft. cutter bar found, whereas in California some farmers are going over to 9-ft. cutter bars.

To keep the hard ground flat for irrigation, reversible disk ploughs are widely used and the British firm arranged with Be-Ge Manufacturing Company to adapt their two- and three-furrow reversible disk ploughs to their tractors by means of a depth skid and slightly altering the automatic reversing mechanism which is attached to the tractor. The disks on these ploughs have an inside bevel which gives a good cutting power.

A loader has also been designed specially for the David Brown 25 series by the Wagner Iron Works, and this will also be accompanied by a rear-end scraper for the purpose of scraping and ripping the land and to give balance to the tractor generally.

The root rake at work on Mr. W. Leonard Hill's estate at Crux Easton, North Hampshire
(*See p. 408, 'Hands Across the Ocean'*)

Rust-Resistant Wheat Developed

A new variety of wheat, suitable for cold climates like those of the north central United States, the nation's major wheat-growing area, will be available for growing in 1956. It is N.D.1, bred by scientists of North Dakota State College.

It is resistant to Race 15-B rust, which has damaged wheat crops seriously in the past, and has a high milling quality which other wheats with high resistance to Race 15-B have lacked.

Its kernel is not as bright as those of most wheats grown in the United States' major wheat belt, but tests show that its performance in the field and in the bakery makes up for any lack in appearance.

NEW PUBLICATIONS

Feeding the Fifty Million

By the Rural Reconstruction Association. Pp. 140. London: Hollis and Carter. 1955. 12s. 6d.

The Rural Reconstruction Association is an independent non-party organisation which has as its aim ' The restoration of agriculture to its rightful place in our national life '. This association set up a research committee in 1947 to investigate problems which lay in the way of increasing agricultural production. This book is a result of the committee's work.

A brief introduction discusses the position of Britain in respect of the balance of food deriving from home and overseas. There follows a survey of Britain's agricultural resources, both of land and of men to work the land. This section and the later and longer chapter on the development of resources parallel the treatment of these same subjects by Sir George Stapledon in ' The Land, Now and Tomorrow '. Much of ' Feeding the Fifty Million ' is indeed an indirect tribute to Stapledon in that it repeats, though with even more force but less charm, the conclusions published by Sir George in 1935.

The reclamation of marginal land is, of course, emphasised as a significant means of increasing home production, although it is probably insufficiently stressed that great improvements in marginal land can only be effectively utilised if there is a concomitant upgrading of the better grasslands in the country to provide fattening pastures for the increased head of stock. Many of Britain's best pastures are maintained at a high level of productivity because they are used solely for fattening; land used for stock rearing suffers more rapid nutrient deprivation and so degenerates more rapidly.

Common land provides special problems for reclamation; the divided responsibility for its utilisation makes for irresponsibility in management. There is no powerful legal means of enforcing the communal owners to manage the land effectively. A similar state of neglect follows a system of land tenure in which fields are let annually by auction. In this case the continually broken tenure of land destroys incentives to pasture improvement. The authors point to the need for a system of security in agriculture, which encourages the investment of capital in forms of land improvement, but which may not yield financial benefit for several years.

Systems of incentive are discussed and the authors suggest a return to a type of income taxation based on estimates of land productivity. The taxation proposed would be based on the average annual profit which could reasonably be expected from a holding and would encourage high-level and penalise subsistence farming.

The book is concisely written—indeed, it is more like a lecture notebook than a text. There is a continuous logic in the presentation and no very obvious emotion or special pleading. Graphs and figures could have made some of the statistics more lucid, but may have been deliberately avoided lest they scare away non-scientific readers.

The book may be commended as a brilliant presentation of complex and interacting problems. It provides an interesting approach to economic problems for one who is not an economist.

JOHN L. HARPER

Flaying and Curing of Hides and Skins as a Rural Industry

Pp. vii + 136, illustrated. Rome: FAO. 1955. 7s. 6d. (U.S.A. $1.50)

This book, recently produced by the Food and Agricultural Organisation of the United Nations, Agricultural Development Paper No. 49, has been prepared by A. Aten, Rural Industries Specialist, FAO, R. Faraday Innes, FAO Consultant and formerly FAO expert on hides and skins in Libya (also formerly on the staff of the British Leather Manufacturers' Research Association), and E. Knew, FAO Consultant and Senior Hides Officer, Ministry of Animal Resources, Sudan; and the authors acknowledge assistance from 11 other experts.

Hides and skins, a valuable raw material, can unfortunately all too easily be spoiled: ' Conservative estimates indicate that the total losses caused by avoidable damage . . . amount to millions of dollars a year '. The illustrations throughout the main body of the book are drawn from Africa. While the principles of flaying and curing are the same the world over, African territories have for many years past formed a fruitful ground for experiment because (i) there is a great supply of raw material both in hides and skins, (ii) the tropical climate can be very exacting and (iii) primitive practice calls so loudly and with such promise for improvement. While much, no doubt, remains to be done and to be learned, these experiments have improved quality from many parts of Africa and added much to the body of knowledge on curing. Of all this the authors have taken full advantage.

The book describes a number of faults arising during established methods of dealing with hides and skins and, very laudably, devotes even more space to describing, largely pictorially, good methods to produce high quality. The early sections give accounts of correct methods of preparing the animals, of killing and of flaying. The importance of flaying to give good shape and avoid flay cuts is well stressed by the ample photographs and sketches, which clearly make their points. Throughout the book the captions form a valuable part of the illustrations. The section on curing of hides and skins briefly outlines general principles and details the main methods—air drying and salt curing—with special reference to conditions in semi-tropical and tropical climatic conditions. The section on drying methods of framing and hanging is again very well illustrated.

Damage and defects are considered and include damage during life, *i.e.* diseases affecting the integument as well as branding—damage caused in preparing hides and skins and damage during storage and transport. Sections are given on grading, folding and baling, on hide trade equipment and its use, and there is a short section on proposed development scheme, with, finally, a useful glossary and a number of selected references.

While the book is intended primarily for less highly developed parts, rural practitioners and students in the U.K. will also find it both valuable and interesting.

MARY DEMPSEY

REPORTS

East Malling

East Malling Research Station Annual Report for 1954. Maidstone, Kent: East Malling Research Station. Pp. 170, illustrated. 1955. 12s. 6d. (U.S.A. $2.00).

The annual report, which has just been issued to members of the East Malling Research Station Association, covers the period 1 October, 1953 to 30 September, 1954, and follows the same arrangement as in previous years, being divided into four parts.

The first part surveys the management of the experimental farm and the crops harvested on the different plots. Notes are given on the marketing of these crops, new plantings and grubbings, the spray programme, arable crops, mainly potatoes, peas and cereals, and the experimental nurseries and glasshouses.

Part two reviews the research work during the year. Many items of great interest to fruit-growers are briefly reported here before a fuller account of the work is published elsewhere. As this part of the report is arranged under the main research sections, reference to any particular part of the research programme is simple. A complete list is given of publications during the year.

Research reports and reviews, written mainly for fellow research workers, occupy the third part, but also included in this part are the full text of the Amos Memorial Lecture on Water and Plant Growth, delivered by Prof. Bennet-Clark, and a historical account of the research station lands in East Malling parish. These two papers have a wide appeal, both for scientists and fruit-growers. There are 22 other papers in this part, dealing with root-stocks, propagation, incompatibility, black-currant varieties and pruning, Climax yellow, frost incidence, pot culture of apples under glass, tasting trials, weather conditions, fruit-tree red-spider-mite trials, effect of spray materials on cropping, growth inhibitors, composition of apple leaves, virus diseases, interesting insects, codling moth and fungicides. In spite of their technical nature, the majority of these papers are full of interest for the progressive grower who makes the effort to read them.

Growers' bulletins in part four are rather fewer in number this year. They deal in everyday language with the search for better fungicides, predacious capsid bugs, and apple orchard practices in Canada.

The report is well illustrated with photographic plates and line drawings and a full index makes all the information readily available. It contains a list of the governing members of the Society, the Executive Committee and the staff.

West African Cocoa

Annual Report of the West African Cocoa Research Institute for the year ended March 1954. London: Crown Agents for the Overseas Governments and Administrations. 5s.

The annual report of the West African Cocoa Research Institute for the year 1953–54 has recently come to hand. It is unfortunate that its appearance is so long after the period to which it refers, since the information contained in it is to some extent out of date.

It is 11 years since the Institute was first organised as a West African institution, and it is reasonable to expect that by now it should have shown substantial results. Its foundation was, to an extent, an emergency measure taken during the last war, because of apprehensions caused by the spread of the virus malady known as swollen shoot disease, which threatened the existence of the cocoa industry in West Africa. In its early years the Institute proved conclusively that the malady could be checked by cutting out diseased trees, provided infection is not too heavy; but so far it has been unable to suggest a satisfactory alternative to this drastic procedure, which gave rise to serious political difficulties in the Gold Coast in the course of efforts to apply it. On the other hand, the Institute has accomplished much valuable research in a number of directions, of which the present report contains the most recent record.

By reason of the continued threat to the cocoa industry, it is not unnatural that the principal preoccupation of the Institute has continued to be with research on maladies of the cocoa tree in West Africa, particularly with virus disease and its vectors and alternative hosts, as well as with the capsid bugs and the Phytophthora pod disease, both of which are serious checks on cocoa production in West Africa.

At one time great interest attached to the possibility of affording protection against virus maladies by inoculating trees with a mild strain. The results at one time seemed promising, but it now transpires that ' protected ' trees may continue to harbour virulent strains of the virus and so continue to act as sources of infection. On this account the method is not recommended.

The list of trees which can function as intermediate hosts for the virus has been extended, notably by the addition of a number belonging to the order Tiliaceae. The indigenous tree, *Cola chlamydantha*, which occurs widespread in the wetter parts of Western Province of the Gold Coast, has been surveyed in respect of its occurrence. Virus infections are very general throughout this range.

An interesting development recorded is the working out of a relatively simple chemical method of diagnosing the presence of virus strains in Amelonado cocoa.

The mealy bug vectors of virus disease have been further studied; one new species of vector has been recorded, *Pseudococcus westwoodi*. Interest has been continued in parasites and predators for the control of mealy-bug vectors of virus disease. Eleven species of parasite have been introduced from abroad, and 16 have been recorded in the country. The work on the control of mealy-bug vectors by systemic insecticides, carried out in collaboration with Pest Control Ltd., of which at one time great hopes were entertained, has been continued. A new technique has been tried by implanting the insecticide in holes bored in the trunk of the tree. The results of this are being prepared for publication. A few new systemic insecticides were received for trial during the year; two, stated to be based on Dimefox with activators added, gave variable results. An interesting new development has been studies of mealy-bug vectors labelled with radio-active phosphorus.

Control of capsid bugs and of the fungus transmitted by them, *Calonectria rigidiscula*, has been further investigated with promising indications; treatments tried included spraying with DDT and a proprietary fungicide,

' Perenox ', as well as with DDT emulsion and carbide-bordeaux mixture.

Twelve four-acre plots of Amelonado cocoa were established in 1953 to provide blocks of uniform material for manurial experiments. Hitherto there has been a paucity of information on manuring cocoa in West Africa; a difficulty has been that of finding areas where results are unlikely to be obscured by disease incidence. It would appear that work in this direction, on cocoa soils and on the curing and other chemical aspects of the crop may have been handicapped by exiguous staff provision.

There appears to have been much activity in plant breeding and the trial of seedlings and clones. Unfortunately, the section of the report dealing with this work is so very condensed and contains so many unexplained reference initials and numbers that it is difficult for the uninstructed reader to follow it.

It is satisfactory that the numerous staff vacancies at the Institute have now been filled. It has suffered so much from frequent staff changes in the past that it is to be hoped that a stable position has now been achieved. Too frequent changes in this regard are a deterrent to successful research. The Director of the Institute, Mr. J. West, retired early in the current year. He will be succeeded by Mr. J. Lamb, Director of the Tea Research Institute in Ceylon.

An important new development during the year was the inauguration of a sub-station of the Institute in Nigeria; this should enable the work of research to be extended in an area where it is badly needed.

As a whole, the report indicates the performance of a large amount of useful but unspectacular work. As a suggestion for future reports, it would be useful if the main points arrived at in any year were briefly summarised in the opening section.

Rothamsted

Report of the Rothamsted Experimental Station for 1954. Pp. 242. 1955. 7s. 6d.

Once again the width and depth of investigations at Rothamsted are an impressive feature of the yearly report. Yet the intermingling of old and new must be rare enough, for, whereas the plots and plot treatments started well over a century ago by Lawes and Gilbert are steadily continued, an electronic computer has been installed in the Statistics Department, antibiotics and antibiotic-making micro-organisms are being investigated for controlling root-disease fungi by the Soil Microbiology Department, and radio-tracer studies of phosphorus uptake are being continued in the Chemistry Department. However, to select this or that topic in a commentary of a few hundred words must be an illogical ' lucky dip ' procedure.

Variable responses to nitrogen in recent farm experiments seem to have stimulated the Chemistry Department to retread old and negative ground in the hope of finding a reasonably reliable soil test for available nitrogen. High seed rates, especially in association with high rates of nitrogen fertilisation, have been shown to encourage eyespot and take-all diseases; cereal mildews similarly increase in incidence with late sowing and high nitrogen fertilisation (Plant Pathology Department). The Pedology Department reports on soil survey progress not only in Britain, but in Nyasaland and Kenya.

The specialised articles, always a notable feature in these reports, deal with ' Clay Minerals ' (G. Brown and R. Greene-Kelly) and ' The Foliar Uptake of Nutrients by Farm Crops ' (Dr. G. N. Thorne). The former article mainly reviews the progress made through the application of *X*-ray-diffraction spectroscopy. In the latter Dr. Thorne reviews most of the work of recent years on foliar sprays with nutrient solutions. The conclusion is firmly reached that this method of applying fertilisers to agricultural crops is unlikely to become very common; in general, it does not offer greater economy or efficiency, though there are unusual circumstances when the method could be preferable to the soil application of a solid fertiliser. These two articles are followed by a most valuable piece of bibliography, a classified list of the late Dr. E. M. Crowther's published work, which was scattered through an exceptional range of journals, monographs, reports etc. For Rothamsted this must have been one of the saddest of compilation tasks.

Despite 1954's unfavourable weather, 2,700 plots and over 500 ' micro-plots ' were handled by the Field Experiments Department. An important development has been the soil-mapping of the classical plots for lime and pH; as a result, liming schemes for Broadbalk, Hoosfield, Agdell and the Exhaustion Land have been approved by the Trust Committee. A liming programme has also been drawn up for the classical plots at Woburn.

D. P. HOPKINS

Vegetable Research

The British Society for the Promotion of Vegetable Research, Annual Report, 1954

This report includes résumés of work undertaken by the different sections of the station, *e.g.* plant breeding, irrigation, entomology, plant pathology.

FAO

Problems of Animal Feeding in Europe

The material on problems of animal feeding in Europe included in this publication shows the important issues facing European farmers arising from the recent trend in the field of animal feeding in this region, namely, the more extensive use of home-grown feeding stuffs. It is based upon the material contained in papers, discussions and country reports presented to the Technical Meeting on Problems of Animal Feeding in Europe, held jointly by the FAO of the United Nations and the European Association for Animal Production, held in Paris, March 1953.

Uses of Agricultural Surpluses to Finance Economic Development in Under-Developed Countries: A Pilot Study in India. Commodity Policy Studies No. 6

In issuing this document it is hoped that it will be helpful to India and will also serve to stimulate other countries to make similar investigations and to take action on them.

Plantations and Other Centrally Operated Estates

This paper is one of a group of connected studies on land tenure and related subjects undertaken as part of the programme elaborated by a conference of FAO. The author is Sir Bernard Ottwell Binns, K.B.E.

MACHINERY AND EQUIPMENT

Scrubcutter

The 'Four Seasons' scrubcutter (The Standard Insulator Co. Ltd., Camberley, Surrey, England) is designed exclusively to cut at ground level all forms of scrub, coarse grass, heather, saplings, thick undergrowth and bush growth up to 3 in. in diameter. A circular saw can be supplied for larger growth.

It is a well-balanced machine designed for easy manipulation. Although light in weight, it is of robust construction and will give much service in what is considered to be extremely heavy work and offers maximum manoeuvrability over banks, hillsides and uneven ground.

Specifications

Engine.—98-c.c. Villiers two-stroke. Fuel: petrol/oil mixture. Air cooled by fan and cowling. Ignition: Villiers flywheel magneto. Carburettor: Single lever fitted with large air filter.

Frame.—Tubular-steel and plate construction.

Cutterhead.—Plate steel to which is fitted the cutter blades through balance weights to ensure even balance. Drive is by shock-absorbing pulley drive with simple tension adjustment. Vertical drive is carried on two heavy-duty ball bearings protected by oil seals.

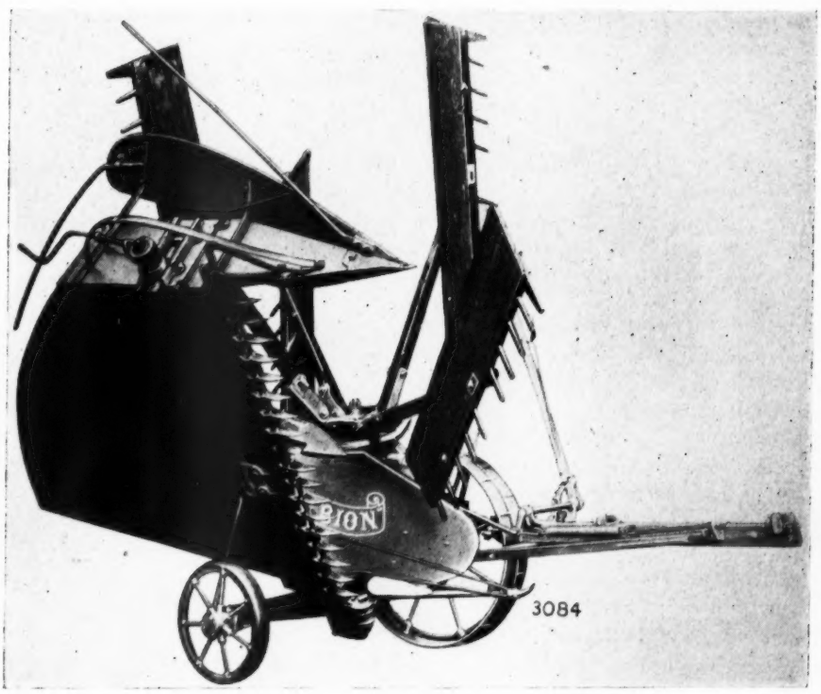
Standard fitments.—Pneumatic tyres. Adjustable handlebars. Two-point lubrication. Non-wrapping spindle guard.

'Four Seasons' scrubcutter, Standard Mark VI. This model is shown with a belt guard, which is an extra. The illustration shows not only the type of undergrowth which the machine is designed to attack, but also indicates how, upon withdrawal after the forward cut, the cut undergrowth is further severed into small pieces

[Photo by Ron Francis]

Albion '12SD' Reaper

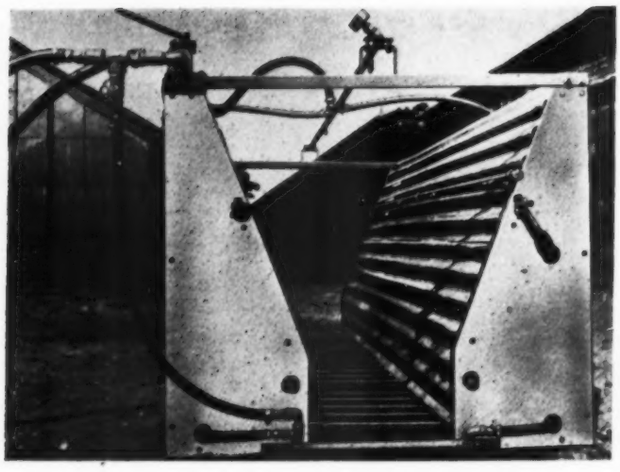
In response to numerous enquiries from abroad, Harrison, McGregor and Guest Ltd. are reintroducing a side-delivery reaper into their range. The '12SD' (four controllable rakes, 5-ft. cut) is similar to earlier models, but it includes two main alterations: (*a*) the platform is now made of metal instead of wood and (*b*) all main gearing now runs in oil-bath gear boxes. Other special features are: (1) it can be supplied with a wood pattern divider or with a steel torpedo outer divider; (2) it can be supplied with closed or open rakes; (3) the reaper folds for transport and the foot rests and seat support fold back for passage through narrow lanes and gates; (4) all controls are within easy reach of the seat; (5) the rakes are easily controllable and may be set to deliver the sheaf every rake (making a swath) or every second, third, fourth or sixth rake, making a sheaf; (6) by a simple pressure of the foot the driver can cause any or all the rakes to pass over the platform without delivering the sheaf.



The new Albion '12SD' side-delivery reaper in the transport position

Sheep Spray Race

The Cooper-Allman sheep spray race (Cooper, McDougall and Robertson Ltd., Berkhamsted, Herts., England) has been specially designed for spraying sheep with Cooper's maggot-fly spray (Dieldrin) to protect them against maggot fly at seasons when dipping is inconvenient, such as before



Fordson Major diesel (right) with pre-set linkage control and F-R four-furrow (TS70) plough shown with YL165K general-purpose bodies

The Cooper-Allman sheep spray race (left) is portable and is easily operated by two men. It is not necessary to handle the sheep

shearing, and is claimed to be a time- and labour-saving development in sheep management. A special advantage of the Cooper-Allman spray race is that it can be lifted by two men and used on any reasonably level site, with temporary pens constructed of hurdles.

The race consists of a wooden floor, with sides of corrugated metal. Along it a series of jets project at intervals from spray-booms placed at varying heights, and a spray-boom is also supported above it. Fan-shaped sprays are directed at the sheep from overhead and along the sides of the race, thus ensuring good coverage as each animal passes through. Power is provided by a complete pumping unit (supplied as an extra) or by a pump (also supplied as an extra) driven from the power take-off of a tractor, or a Land Rover, which pumps the liquid through hoses from any suitable spray reservoirs, such as two 40-gal. drums. Two 20-gal. tanks are fitted on each side of the race to collect excess wash.

As the sheep start to pass through the race the control valve is opened and the speed of the engine or tractor regulated to maintain a pressure of 12–15 lb. per sq. in. on the pressure gauge. As soon as one 40-gal. drum is emptied, the hoses are changed to the other while the first is being refilled, and so on. For every 40 gal. used, about 10–15 gal. will be collected in the side tanks, and this wash is transferred back to the main reservoir by closing the control valve and opening the suction valve.

The speed with which sheep can be treated varies according to the breed, length of fleece, and arrangement of the entrance and exit races. With a good arrangement, about 40 sheep per minute can be treated.

With large sheep in full fleece the number may be reduced to about 30, but with lambs and shorn sheep as many as 60 per minute may be passed through.

This machine was recently awarded a Silver Medal by the R.A.S.E. for new implements at the Royal Show (Nottingham) this year.

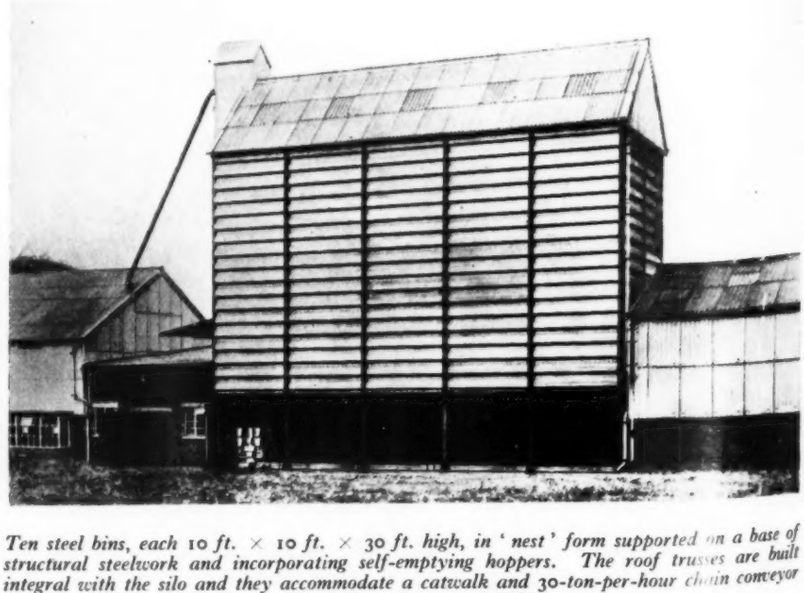
Grain-Storage Silos

Crittall Manufacturing Co. Ltd., Braintree, Essex, England, have announced that they are able to supply self-supporting prefabricated grain silos. These have the advantage of being supplied in sections and thus are simple to handle and easy to erect by unskilled labour.

The silos are made of hot-dipped galvanised steel, the corrugated sheet panels being bolted to the corner posts. They can be put up singly, or in ' banks ', or in ' nests ', and they can be added to as required. A basic silo has four sides and four corner posts, but its capacity can be doubled by adding three more sides and two corner posts.

Pre-Set Linkage Control

A new design development has been announced by Ford Motor Co. Ltd. In conjunction with Ransomes they have produced a pre-set linkage control and four-furrow plough, ' power-matched ' to the Major, to encourage optimum tractor loading.



Ten steel bins, each 10 ft. × 10 ft. × 30 ft. high, in ' nest ' form supported on a base of structural steelwork and incorporating self-emptying hoppers. The roof trusses are built integral with the silo and they accommodate a catwalk and 30-ton-per-hour chain conveyor with feeding spouts to each bin

WORLD CROP REPORTS

HUNGARY

General

Crop prospects are good in Hungary this year, reports the Central Bureau of Statistics in its review of the second quarter of 1955.

Because of the late spring, sowings started late but were carried out successfully. Maize was sown on 210,000 more acres than last year (2,800,000 acres) and the rice-sowing area was extended by 21,000 acres through the extension of irrigation from the new Eastern Canal.

Good weather in the last few weeks has increased crop prospects and the yield of eared crops was expected to be greater than last year. Outstanding yields of potatoes and certain fruits were expected.

RHODESIA and NYASALAND

Tobacco. Provisional estimates indicate that Southern Rhodesia's tobacco crop this year will be only slightly less than last season's record crop of 120,500,000 lb. Giving this estimate recently, an official of the Southern Rhodesian Agricultural Department said the quality all over the colony, except in the Midlands, was ' pretty good '. He attributed this to the exceptionally early planting of a high proportion of the crop, which would otherwise have suffered badly during the December rains. An official of the Central African Statistical Office, however, said figures of the acreage planted would not be known until the end of April. Native grain crops should be extremely good, given reasonable spells of sunny weather, according to reports of Native Commissioners. A statement issued by the Native Affairs Department said crops dry-planted in some districts had benefited from the early rains and were now well advanced. A marked improvement in methods among native farmers had also contributed to the very optimistic outlook.

Nyasaland tobacco planters have this year produced 7 million lb. less tobacco than last year, according to the latest estimates from the Tobacco Control Commission. An estimated total for this season's crop is 26,441,500 lb., compared with a total of 33 million lb. last season. Southern Province auction floors opened on 21 April and the first curings were reported to be thin and bright. Only two-thirds of last year's crop is expected from the Central Province, with the crop thin and light in weight and with a high proportion of short leaf. The late planted crops were spoiled by bad weather conditions.

ISRAEL

Citrus. There are good prospects that a total of 7.25 million crates of citrus will be exported this year. This figure is higher than previous estimates had indicated.

It is expected that there will be no shortage in crates, despite the fact that exports will be higher than estimated. There is a sufficient supply of crates in the country to satisfy demand in the near future. Orders for wood for additional crates have been placed.

A total of 3,280,665 crates of citrus were exported between the beginning of the present citrus season and 15 February, 1955. Of these, 2,614,192 crates contained Shamuti oranges, 457,400 crates of grapefruit, 165,379 crates of lemons and 43,694 crates of miscellaneous citrus fruit.

Vegetables and peanuts. Recently published figures relating to the area under vegetables, potatoes and peanuts indicate that the area under these crops has expanded more than threefold over the past five years.

The total area under vegetables, potatoes and peanuts in 1949–50 was 42,213 dunams. This year, however, a total of 140,302 dunams were planted with these crops. The largest expansion has been in the area under peanuts. In 1950–51 this area amounted to 790 dunams, whereas this year the area under peanuts is 41,116 dunams.

INTERNATIONAL

Wheat

Current supplies.—Latest available estimates indicate that supplies of wheat remaining on or about 1 June, 1955, in the four major exporting countries for export and for carry-over at the end of their respective crop years amounted to 1,785.3 million bushels, about 1% less than the 1,802.7 millions available a year ago. Supplies at 1 June, 1955 (in millions of bushels) were held as follows, with last year's figures in parentheses: U.S.A., 1,001.8 (921.3); Canada, 513.0 (628.2); Argentina, 137.6 (121.6); and Australia, 132.9 (131.6). Estimates for both years include on-farm stocks as well as those in commercial positions.

Exports.—Total exports of wheat and flour in terms of wheat from the four major exporting countries for the first ten months (August–May) of the current Canadian crop year, at 629.6 million bushels, were some 20% greater than the shipments of 526.1 millions during the comparable period of 1953–54. Shipments from each of the four countries during the August–May period of 1954–55 and for the comparable period of the four preceding crop years are shown below.

Notes on new crops.—According to the 4 July issue of *Foreign Crops and Markets*, the 1955 wheat harvest recently completed in *India* is the largest on record. Based on preliminary official estimates, the current production is estimated at about 317 million bushels. A crop that size would be 9% above the large 1954 harvest and 49% above the low 1945–49 average. A substantial increase in acreage accounts for the increase over the 1954 out-turn. Present indications point to yields averaging

EXPORTS OF WHEAT AND FLOUR IN TERMS OF WHEAT, AUGUST–MAY PERIOD, WITH COMPARISONS

(million bushels)

August–May	*U.S.A.*	*Canada*	*Argentina*	*Australia*	*Total*
1950–51	304.6	178.8	75.8	106.5	665.7
1951–52	413.5	268.5	24.1	81.1	787.2
1952–53	279.8	297.5	19.2	84.8	681.3
1953–54	170.7	209.1	94.1	52.2	526.1
1954–55	227.2	208.7	112.0	81.7	629.6

about the same as in 1954. Yields in 1954 were above average.

Latest official estimates place the 1955 wheat crop in *Japan* at 51 million bushels. Though above average, this is about 5 million bushels less than the large 1954 crop.

Broomhall stated on 5 July that weather and crop advices from Europe were predominantly favourable during the previous week. Seasonal warmth was stimulating growth over much of the Continent and the tendency in a number of countries was to increase preliminary forecasts of prospective production of wheat and other crops. *Italy* expects a near-record harvest, with the crop there almost assured, as the harvest is well along in the southern half of the country. Growth has been rapid in *Germany* and comment on the Turkish grain crops remained very optimistic.

Rice

The world rice crop for 1954–55 is now estimated to be the second largest on record, the International Federation of Agricultural Producers reports.

The crop is expected to be 261,200 million lb. This is 4.4% less than last year's record-breaking crop. This year's rice production is estimated to be 17% above the post-war average.

Rice output in Asia this year is down sharply from last year's large crop. In Europe the crop is also below that of a year ago. But production increased again in Africa and in North America. There also will be a small increase in South America.

Asia's harvest of rice accounts for about 88% of the world's total production. Acreage was only slightly below last year for most of Asia, but bad weather hampered the crops.

ENGLAND AND WALES

Agricultural report.—Agricultural conditions in England and Wales on 1 August, 1955, have been summarised by the Ministry of Agriculture, Fisheries and Food. Weather conditions were generally favourable for corn crops, which made good progress during the month; yields are expected to be a little above average.

Conditions also favoured haymaking, which was virtually finished in most areas. Root crops are satisfactory but rain would be beneficial. Cattle and sheep have done well.

Weather conditions

Apart from thunderstorms, which were heavy in some areas, the weather during July was mostly warm and dry with sunshine and temperatures above average.

Corn crops

Wheat is generally a satisfactory crop and is standing well. On the basis of crop conditions at the end of July, the yield of wheat is forecast at 23.5 cwt. per acre, as compared with a five-year average (1950–54) of 22.4 cwt. and a yield of 22.6 cwt. in 1954.

Barley is a satisfactory crop on the whole, but dry conditions have caused premature ripening or burning on some lighter soils. Lodging has occurred in a few areas. The yield of barley is expected to be 22 cwt. per acre, as compared with a five-year average of 20.6 cwt. and a yield of 21.4 cwt. in 1954.

Oats are generally a good crop, although some later sowings are variable. Premature ripening owing to the dry weather is reported from some areas. The yield of oats is forecast at 20.1 cwt per acre, as compared with a five-year average of 19.3 cwt. and a yield of 19.2 cwt. in 1954.

Rye is standing well and is a promising crop. The yield is forecast at 18.5 cwt. per acre, as compared with a five-year average of 18.2 cwt. and a yield of 18.5 cwt. in 1954.

Sugar-Beet

Sugar-beet made good progress in most areas during the month but needs rain. Black aphis attacks are reported from some areas. The yield per acre is expected to be a little below average.

Roots

Turnips and swedes are a satisfactory crop, although growth has been checked by dry conditions in several areas. Some crops are very weedy. The yield per acre is expected to be about average.

Mangolds are recovering from earlier mangold fly attacks and made progress during the month, but growth was slow owing to lack of moisture. Many crops are weedy and some black fly attacks are reported. The yield per acre is expected to be about average.

Fodder beet is generally satisfactory, although slow to make growth in many areas; rain would be beneficial. Weeds are prevalent in a number of crops.

Kale

On the whole, kale made good progress, but some later sowings are backward. Rain is needed. Many crops are rather weedy, and pigeons have been troublesome in some areas.

Hay

Haymaking was virtually finished during July in excellent weather. The general conditions and feeding quality of the crop are reported to be good.

The yield of *seeds hay* and *lucerne hay* are now forecast at 32.8 cwt. per acre and 43.5 cwt. per acre respectively, as compared with 29.1 cwt. and 42.2 cwt. in 1954 (five-year average 30.2 cwt. and 44.5 cwt.). The yield of hay from *permanent grass* is forecast at 22.8 cwt. per acre, as compared with 21.3 cwt. a year earlier (five-year average 21.2 cwt).

BRAZIL

Bean production

The 1955 bean harvest in Brazil is expected to be 15% less than the record 1954 harvest of 35,620,000 bags of 100 lb. each. This is not an official estimate, but is a forecast based on preliminary reports of the wet-season crop harvested last December and January. Seeded acreage of the wet-season crop was reduced by low prices and plentiful stocks at planting time last September. Also, dry weather in late 1954 reduced yields.

Brazil is a minor international trader in beans. Only 27,000 bags were exported in 1954, and 132 bags imported. The exports went to Mexico, 11,000 bags; Switzerland, 8,000 bags; Japan, 7,000 bags; and Uruguay, 1,000 bags. The imports were white beans from Chile.

Brazil appears to be the world's largest producer of the common type bean, *Phaseolus vulgaris*. India, China and other Oriental countries produce very large tonnages of beans, but many of these beans are the soya and mung types.

Brazilian production is about two-thirds of black beans, one-third of brown and spotted beans, and less than 1% of white beans.

Foreign Crops and Markets